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ELECTRICAL INVESTMENTS.

ELECTRICITY is rapidly becoming a speculative medium. A glance at the list of provisional orders sets the mind thinking of the vast amount of capital which will have to be embarked if a quarter of them only are to be carried out, and, whether the hopes of all the promotors will be realised. For, on the system adopted must depend the profits to be gained; and if the transformer or the secondary battery be the more economical has yet to be decided. Electricity has weathered many troubles, and this question will decide itself, perhaps in the coming year.

Illuminating gas, in its early days, had its trials like all young things, and it was a long time before it cut its teeth and got over its infantile disorders. It started by lighting the streets. It would never be available for lighting houses, that was certain. No sane man would have it. It would blow up any lunatic who tried it, unquestionably. But the British Isles being populated by "mostly fools," according to Carlyle's dictum, its inhabitants were cajoled by the gasmen into its use; and, presumably, the blow-up portion was so small that, where the angels feared to tread, others rushed in, and, lo! nearly every house in Christendom is lighted by its agency. "He's got a lot of gas shares" is quite sufficient to account for a full waistcoat and comfortable circumstances.

It is a well-known fact that it is not to street lighting that the wealthy gas corporations look for their revenue, but to the meter returns of the houses. The gas companies are vested with great powers, and have become a huge monopoly. Ostensibly, this is not the age of monopolies. They are corrupt, and the age is virtuous. When it became evident that it was possible to light streets and houses by electrical means, the powers that be, guided by the light which gas had thrown upon them, bethought them that they would show their wisdom by guarding the weak ones, who might be tempted, like moths, to fly to the new light, from getting burnt in the transaction. A Bill was framed which most effectually encompassed its object; it did more, it effectually prevented the general adoption of electricity, and nearly stifled for a time the electric lighting industry. Rumour had it that gas shares were at the bottom of that Act. But rumour is a notorious liar. They were doubtless "all honourable men," but misguided. Electric lighting was a robust child, even in its infancy. It was not to be denied. It did a little crying, and then went to school and learnt its letters diligently. Very many of the companies and firms started for its exploitation, finding their sphere narrowed, and their profits nil, succumbed, and their *personnel* were scattered, like the dragon's teeth, only to raise up a noble army of electrical engineers, all of them ready and willing to put the light into your house at the shortest possible notice—for a consideration. But it is the consideration which is the rub. "Can you give it me at the same price as gas?" is the almost invariable question put by the enquirer after truth concerning electric light. He does not care to take a leap in the dark, which would land him in light, without economy to sweeten it. But the name of those who have indulged in its refulgence, regardless of the initial outlay, is legion. Men having valuable pictures and costly decorations have doubtless seen a real saving in its adoption, and have accepted it. Many of the wealthy have needed no other reason than that, seeing its superiority, they have meant to have it, and given the order. It is a luxury, and as such, has to be paid for. There are no statistics to show the number of isolated plants at work; but they are much more numerous than those who are not alive to the question have any conception of, and the amount of capital already laid out by private persons must total up to a very considerable sum.

It is probable that the first electric lighting Act did good in a way which was not intended. The stagnation which it caused gave time for the perfecting of details, and saved the squandering of much money on undigested schemes. The time, however, of pupilage

is passed, and given more security by the amending Act, the electric lighting industry, without nursing or undue favours, is quite capable of taking care of itself. It is not to be expected that the light can be within the means of the struggling classes, but there are many localities denizened by those who are willing and able to pay a reasonable price for the great advantages which it has to offer over its rival, gas. Now, that instead of every house having its separate plant, districts are being operated from central stations, not only will the charge be placed upon an acceptable basis, but such enterprises ought undoubtedly to be profitable. That is now a mere question of figures. There is no longer any question as to the possibility or failure. If only the capital be forthcoming, and a good proportion of the inhabitants of any well-to-do neighbourhood put down their names as willing to have their houses electrically lighted, the thing is done. In the United States even the little towns have their central lighting stations, and they pay. There are several on the Continent also paying. It is in connection with central station lighting that the future of the new illuminant lies, and we predict that it will not take long to prove that that future will be as bright as electricity can make it. John Bull was ever cautious and suspicious of new ways. He didn't believe in gas at first. He didn't believe in the Suez Canal. But he always accepts accomplished facts, and has an eye to an investment which is proved to be a paying one. He has been scared by the mad boom in electrical shares and the subsequent collapse, and is, not without reason, coy; but let him see dividends being paid by central lighting syndicates and companies, his bashfulness will vanish, and he will bestir himself and kiss the rising sun. Fortunately, even among us phlegmatic islanders have been found men with a stomach for adventure, who have been willing to go into untrodden regions; and we trust these bold spirits will be amply rewarded for their enterprise.

We are watching with great interest the race for provisional orders. The knowing ones, the good old promoters of the recent past, have entered for a large number, and herein lies the danger. History repeats itself, and we cannot but fear that imprudent speculation and company-mongering may do much harm to the industry. While welcoming every solid and necessary undertaking, and seeing in such a legitimate opening for capital with the chance of very good dividends for the investors, we would suggest to our readers that they should carefully scan the prospectus for the names of old offenders, and to see that the directors are those who will be likely to work in the interests of their companies only. We also advise their ascertaining that there is a real want for the light in the localities which they intend to serve, and that the system to be adopted is economical.

UNDERGROUND WIRES.

THE schemes for electric lighting, which are on the verge of springing up in all directions, seeing that 400 at least are to come before Parliament next year, will probably result in the much vexed question of underground conductors being solved in more ways than one, and will also occasion numerous patents being taken out for, so-called, new ideas in connection with the same, most of which, however, will be consigned to oblivion. For low tension systems the question will not be a difficult one, but even here the first essentials to success are good manufacture, good supervision, and good scientific advice. The latter is too often ignored, with the result that instead of a saving being effected imperfect work is laid down, which causes constant trouble and endless expense. We have over and over again asserted that underground work for electric light purposes should be as carefully done as is the case with submarine cables, and we again say that this should be so. Important as good work is for low tension systems, it is vastly more so in cases where high tensions are to be used, and should the latter come into extensive employment a radical change will have to be made by manfacturers in their system of testing the wires. The present method of testing with a high voltage obtained from small sized cells will have to be abandoned for, or rather supplemented by, a system of testing in which high voltage dynamos are employed, not occasionally, but as part of the regular system of manufacture. In favour of the bare wire system there is much to be said; for low voltages there is little reason why it should not prove successful, but success depends, we believe, on a system of artificial ventilation of the conduits being adopted so as to clear out and prevent the deposition of moisture. This has been suggested more than once, we imagine, but in no case does it appear to have been carried out. Probably the best system of all to employ, though a comparatively expensive one, is a combination of the two, *i.e.*, well insulated wires laid in conduits, so that no direct digging up of the cables is required in order to repair faults, and no injury by pickaxes or punners is likely to take place.

We are told that Mr. Price, of the well-known firm of electrical auctioneers, has convened a meeting of the trade for the purpose of advocating a general rise of prices of electrical plant—we mean the apparatus, not the journal of that name. In discussing the matter with a friend, we were assured that the best mode of effecting the object which has evolved itself from Mr. Price's fertile brain would be for his firm to cast all its second-hand appliances into the sea.

OUR infallible friend in New York, the *Electrical Engineer*, falls foul of Mr. Edison's assertion that there is no known insulation which will confine the high tension currents for more than a limited period. As a matter of fact, says our contemporary, whose leaning towards a well-known high tension alternating current system is an open secret, the allegation is not true. We fancy that Mr. Edison's meaning has not been exactly grasped, for everybody, including the "Wizard of Menlo Park," knows that wires can be thoroughly insulated for the purpose, but at what cost? It seems

likely that Mr. Edison intended to convey the impression that wires carrying a current under an alternating E.M.F., of, say, the Deptford standard, could not be insulated for a permanency at a price which should not be considered prohibitive, and in this we think the famous inventor will, eventually be found correct.

A NEW electric brake, the invention, we believe, of Professor Forbes and Mr. I. A. Timmis, has been tried on the London and North Western Railway. It acts in an entirely different manner to any other now in use, as the retarding effort is not applied to the periphery of the wheel but to its inside face, or rather upon an iron disc fitted to it. The experiments made in stopping carriages running at thirty and forty miles an hour were eminently satisfactory, and the oscillation and bumping which one so often experiences when the brake is applied seem to have been conspicuous by their absence, or at least only slightly appreciable.

THE news comes from New York of another death from contact with an electric wire. From the public point of view it is even more alarming than those preceding, as it is considered difficult of explanation. A fireman named Sullivan, employed by the Manhattan Electric Light Company, turned a steam valve, while carrying a 16-candle incandescent lamp in his left hand. At the time Sullivan was working alone. When the next person entered he was found quite dead. The burns on his body showed that the current had passed through him from the left hand to the right ear. The occasion of the alarm is that it is supposed the man was killed by a current under an E.M.F. of 120 volts. We cannot, however, reasonably accept this theory. The more probable assumption is that the death-dealing current came from a high tension electric light wire which by some means came into contact with the one held in the hand.

KESWICK, a small town of 3,000 inhabitants in the Lake District, may be congratulated on its manifest spirit of progress. The electric company which was formed in the early part of the present year has already done good work. Many customers are applying for the light, and about Christmas there will be a full supply of the current turned on. The light will be measured to the consumers by meter, and it is estimated to cost a price equivalent to gas at about 3s. 6d. per 1,000 feet, which is about 9d. per 1,000 less than the actual cost of gas in Keswick.

THE opposition of the Exchange Telegraph Company to the granting of a patent to Messrs. Wright and Moore, for a column printing telegraph instrument, which was heard before the Comptroller of Patents on Monday, ended in favour of the Column Printing Syndicate. All the objections of the Exchange Company were abandoned except one, which appears to be of a trivial nature, and the patent will accordingly be issued to Messrs. Wright and Moore. Mr. Moulton, Q.C., characterised the objections as being so frivolous that he felt sure his learned friend, Mr. Graham, who appeared for the Company, would not attempt to defend them in Court.

NO longer will the subscriber to an American Telephone Exchange, in answer to his ring-up, be greeted with the familiar and expressive "hollo!" from the cheery lips of the deity who presides at the Exchange. The word has been banished from the sacred precincts. Perhaps, as the word is generally pronounced "hello," it may be considered to savour too much of the profane, and to suggest a desire to communicate with a far land with whose inhabitants angels should have nought to do.

THE Julien Company states that the new batteries, employed in propelling tramcars in New York, show a fall of potential of 10 in a run of 12 miles, against a loss of 30 in their old form.

A CORRESPONDENT writes:—"I have read through the article about Flood Page's scheme. It is, as you say, absurd, especially the examination part. I would undertake to set an examination paper which would stick every Professor on the Council of the Institution of Electrical Engineers, and I am perfectly certain each of them could set a paper which would stick me. Who, then, shall set the questions? Is he to be a practical or theoretical man, or is it to be the Council? The members of the latter would certainly be plucked. Imagine one of them setting down to answer, What is a watt? How do you measure power? What do you understand by the specific resistance of a rabbit skin? Do you consider it safe to sit on a barrel of gunpowder while embracing in a thunderstorm a lightning rod? &c., &c."

THE tests of the Eiffel tower lightning conductors given in our present issue, though they show that the conductors themselves are in good condition, are hardly conclusive as to the goodness of the earth connection. We are aware that the method of testing employed is one which is very generally used and which is considered to be satisfactory, but it really does not prove that the earth is good, *i.e.*, that the lightning has a perfect path to escape by. What is really proved is that *the mass of soil in which the conductors are imbedded conducts well.* If we could imagine the whole mass of earth to be enclosed in an insulated rocky basin, it is evident that the tests obtained would still be practically the same as those observed, but it could hardly be argued that the lightning would therefore have a free path along which to dissipate itself.

THE New York *Electrical Engineer* in its last number says, in defence of the high tension alternating current transformer system:—"There is not a solitary instance on record of a consumer having been killed, or even injured ever so slightly, by the alternating current, as a 50-volt current, incapable of harming a child, is the maximum which is allowed to enter a consumer's premises." Yet it is possible that the primary and secondary wires of the converter may not always be safely separated, as witness the *Standard's* telegram in our other columns, for in what other way can we account for the result? Captain Cardew might dilate on this circumstance to some advantage, for the fact of having patented an "earthing device" must have made it manifest to his mind that such accidents as this latest American fatality seems to indicate, were always liable to occur. Is it not high time that measures are taken in this country to reduce to a minimum the dangers of alternating current systems?

CONTACT ELECTRICITY AND THE CHEMICAL THEORY OF THE GALVANIC ELEMENT.

NEARLY a year ago, it may be remembered, there was an interesting paper in the *Zeitschrift für Physikalische Chemie*, contributed by W. Ostwald, which consisted of a detailed account of a series of experiments which were undertaken by him in order to ascertain the difference of potential between certain metals and solutions. These experiments were carried out by means of dropping electrodes of mercury.

The differences of potential investigated were those between the metals—zinc, cadmium, tin, lead, iron, copper, bismuth, silver and mercury, and aqueous solutions of the following acids:—namely, hydrochloric, hydrobromic, hydriodic, nitric, sulphuric, phosphoric, formic, acetic, oxalic and benzoic. In the original paper all the results are tabulated.

In prosecuting this research Ostwald experienced considerable difficulty in eliminating the difference of potential between the mercury electrodes themselves and the solutions. He endeavoured to overcome this difficulty by adjusting the aperture from which the mercury issued, and regulating the flow of mercury, but although the source of error was minimised it was never got rid of.

The difference of potential between a metal and an acid depends upon the nature of each, though probably that of the metal has the more marked effect.

In Ostwald's experiments zinc and cadmium were found to give negative results, whilst copper, bismuth, silver, antimony and mercury yielded positive results; tin, lead and iron, however, afforded both positive and negative values of the potential difference.

The effect of the nature of the acid is exemplified in the results with the haloid acids. The difference of potential is generally smaller. The solutions used by Ostwald were normal, deci-normal, and centi-normal, and he observed that dilution increased the negative and diminished the positive potential.

If the difference of potential between these metals and acids be compared with the heat developed when they act upon one another chemically, a striking resemblance is at once noticeable, showing that the order of these values is somewhat similar. When, however, assuming that chemical energy is entirely converted into electrical energy, the difference of potential is calculated from the heat value, the result is found to be very unsatisfactory. This seems to indicate that the assumption cannot be upheld. The investigation of this difficult but attractive subject has more recently been continued by F. Exner, whose papers on "Contact Electricity" in the *Monatshefte für Chemie und Verwandte Theile anderer Wissenschaften* are well known. In his researches on the theory of the galvanic element he has been assisted by J. Tuma. They recently contributed a paper to the *Monatshefte* (*vide* IX., pp. 903—943), in which the weak points in Ostwald's work are discussed, and several sources of error suggested which he seems to have overlooked.

Exner and Tuma consider that dropping electrodes of mercury produce untrustworthy results, because of the chemical action of the electrolyte upon the mercury and the subsequent occurrence of polarisation. Thus, in the case of dilute sulphuric acid, the chemical action of the electrolyte was found to produce a marked difference in the result, equivalent to 0·84 Daniell, while the polarisation produces an effect varying between 0·8 to 1·2 Daniell.

The work of J. Moser on the resolution of the electromotive forces of galvanic elements into their differences of potential (*vide Monatshefte*, VIII., 508—509) is exposed to the same criticism. The same may also be said of the researches of J. Miesler on the resolution of the electromotive forces of such galvanic elements as the Marié-Davy, De la Rue, and Niaudet.

Messrs. Exner and Tuma believe that these sources of error may be eliminated by an arrangement which may be briefly described as follows:—The mercury is allowed to drop into a cylinder of filter-paper wetted with the acid solution in which the metal under examination is immersed, and the cylinder is connected with the acid bath by means of a thread similarly wetted.

A series of metals and acids were examined by means of this arrangement, and in every case, except that of platinum with carbon in concentrated nitric acid, the metal was found to be negatively charged. Probably this exception was only apparent, and may have been due to the formation of nitrous acid in the solution.

Messrs. Exner and Tuma further showed that the values of the potential differences of the metals in the metallic salts of the acids were the same as those values of the metals in the same acids.

Ostwald has recently replied to these criticisms in a short paper in the *Zeitschrift Physik. Chem.*, III., pp. 354—358. He endeavours to substantiate his results, and points out that they agree with those obtained from observations of the maximum surface-tension. The statement that chemical action and polarisation occur is questioned.

This subject has now assumed a controversial aspect, and it would be premature to attempt to sum up at present; all that can be done here is to indicate the views of these different physicists, so that others may be attracted to lend their energies to the elucidation of an extremely interesting problem.

ON AN ARRANGEMENT OF THE PRONY BRAKE, INTENDED FOR THE EXACT VALUATION OF MOTIVE COUPLES.

By M. HILLAIRET.

THE greater number of absorption brakes used in industry for estimating the work of machines present the same general arrangement, and the motive momentum is counterbalanced by the momentum of a force that is almost always single, and acting on one side only of the brake pulley. At the time when this force brings into equilibrium the motive effort, it gives rise to a translating resultant of the same magnitude and direction, which acts upon the bearing of the axle, so as to press more or less upon it according to circumstances. This parasitic action of the motive axle upon its bearings gives rise, upon contact with the rubbing surfaces, to a variable effort, the momentum of which detracts from the apparent value of the motive effort, so that the work estimated upon the brake represents only the motive work, minus the work of the friction mentioned above.

Now, the latter is essentially variable as it is proportional: 1. To the variable charge of the brake; 2. To the coefficient of friction of the surfaces in contact, which itself varies according to the lubrication. It is impossible to estimate it exactly at each moment during a series of trials. We are thus generally compelled to leave out of our calculations an item, the value of which may in certain cases amount to 4 or 5 per cent. of the quantity to be measured.

Having recently had to make some very exact tests in order to determine the gross mechanical rendering of an electrical transmission of 500 H.P., I directed my efforts to the elimination of this parasitic work, endeavouring to realise a resistant couple that would bring the motive couple into exact equilibrium, so as to suppress any resultant of translation.

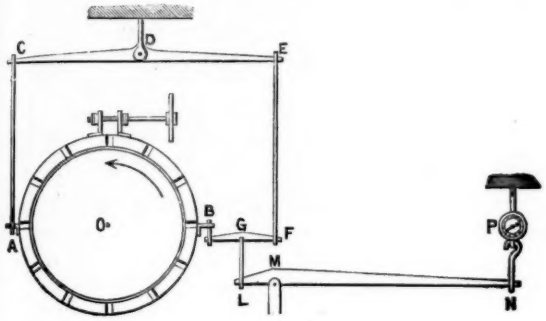
The arrangement of the brake (*Comptes Rendus*) with a couple thus obtained is shown in the diagram below.

It will be seen that the counteracting effort is obtained by means of the spring of a steel-yard spring balance.

Although the employment of the steel-yard in brake measurements is not new; it is worth while to remember that it greatly facilitates trials followed by variable powers, the tightening of the collar

being sufficient to make the effort vary. Besides the exactness that this arrangement gives in valuations, we may also mention the absolute security resulting from its employment, the *ensemble* of the scale beams and rods being firmly fixed in their position, and the course of the spring being only a few thousandths of the length of the lever arm, M N.

O, motive axle; A K B, collar of the brake; V, fly-wheel for tightening the collar; C E, beam oscillating from the fixed point, D; C A, E F, attaching rods; B F, coupling balance; G L, connecting rod; L N, lever for reducing the efforts oscillating at M; P, spring-balance.



This idea has been carried out for the measurement of work supplied and transmitted by the electrical transmission of the Chevrant works, at Domène Isère.*

The dimensions of the brake employed are—

Diameter of the pulley	1·000 m.
Size of the rim	·400 „
O A = O B	·099 „
L M	·200 „
M N	2·000 „

At N two spring balances were adjusted, of 100 kilogrammes each.

The weight of the balance, B F, and the rod, G L, was 24 kilogrammes, and that of the lever, L N, was given by the preliminary displacement of the spring balances when empty, and amounted to 15 kilogrammes. The collar being greased and the rim wetted on the inside continuously, the tests were able to be prolonged during several hours.

The maximum work, as estimated by this method, was 300 H.P., with an angular speed of 240 turns per minute.

* Since the end of last September the Chevrant works (paper manufacture) have been supplied with power by an electrical transmission effected by means of two machines, generator and receiver, separated by a distance of 5 kilometres. The generator, having a maximum power of 300 H.P., is driven directly by a turbine of the same power, making 240 revolutions per minute, and receiving the water of a fall of 70 metres, drawn from the stream called the Domenon, and turned into a channel lined with steel plate, 700 metres long. The receiver can, at its maximum, develop 200 H.P. at the rate of 300 revolutions per minute.

The two dynamos are connected by a line formed of two cables of naked copper, with a section of 50 mm. The transmission is working day and night, with two intervals of rest of 20 minutes each, morning and evening.

The turbines and the relays of steam engines, the place of which is intended to be supplied by this transmission, are stopped, and the corresponding boilers extinguished. The principal electrical data of the transmission are the following:—

Maximum electromotive force ...		2,850 volts.
Maximum intensity of working (*régime*)		70 ampères.
	Resistances.	
Generator	Inductors	·950 ohm.
	Armature	·984 „
	Total resistance ...	1·954 „
Receiver	Inductors	·731 ohm.
	Armature	·690 „
	Total resistance ...	1·421 „
	Line	3·474 „

Total resistance of the circuit 6·829 ohms. Total loss of charge at 70 ampères: 6·829 ohms — 70 ampères = 475·03 volts.

Electrical rendering calculated from the resistances:

$$\frac{2,850 - 478}{2,850} = \frac{2,372}{2,850} = \cdot 83.$$

The gross mechanical rendering, determined by the measurements upon the brake (by substitution) of the turbine and the receiver, varies between ·63 and ·66 in the maximum of work. The insulation of the machines and the line did not lead to any accident or miscalculation, and the superintendence of the installation is not in any way dangerous.

ELECTRICAL RANGE FINDER.

OF the many valuable inventions in modern warfare, says *Modern Light and Heat*, which have emanated of late from Lieut. Bradley A. Fiske, United States Navy, perhaps none is more worthy of consideration than his recently patented apparatus for finding the range and position of distant objects through the agency of electricity. For some time past secrecy has been maintained regarding the details of this device, though it has been known in well-informed naval circles that such an apparatus had either been or was about to be patented, and that its salient features consisted in the determining of the exact range of any distant object by keeping trained upon it a telescope, which in moving carried along with it a dial parallel with the telescope. This dial, it was understood, had electrical contact with a graduated arc over which it moved, and by means of ranging angles registered accurately the distance of the object from the apparatus during all varying stages.

By the means of a simple train of a telescope Mr. Fiske proposes to know at all times just how far away is the position of the enemy, and from thus knowing that position, accurately to impart the information to the batteries and secure a sight adjustment that is absolutely correct. This, in brief, is the underlying principle of the "range and position finder;" to what further practical uses it can be applied will be seen from the description, but that it is a success is undeniable, and the chances are that with the thorough practical tests to which it will be subjected on board the flagship *Chicago*, where the first apparatus has been placed, it will be found essential for accuracy of firing on all the new ships.

The invention of the "range and position finder," as Mr. Fiske puts it, consists in the determination of a fractional portion of a conducting body bearing in length a ratio to the angle included between two lines of sight directed upon some distant object, and the measurement of the electrical resistance of said length.

The electrical device consists of an ordinary Wheatstone bridge with its four members, in one member of which is arranged a body of conducting material in arc form and a movable arm traversing this arc. There is also the transverse member, in which is connected the galvanometer. A battery is connected to the bridge in the usual way. In two of the members are placed fixed resistances, and in the adject member to one containing the arc form is a variable resistance placed as usual. One wire from the battery connects to the end of a member containing a fixed resistance, and at the same time to the pivot of the swinging arm which plays over the arc form. The extremity of this pivot arm moves over and maintains electrical contact with the arc form of conducting material, which latter has one extremity connected to a member of the bridge. Now, when the point of this arm is brought in contact with the member having connection with the arc form, the dial at that moment is in prolongation of this member, and the pivot of the dial having wire connection with another member, there will at once be a current traversing directly from member to member instead of, as before, through the medium of the intervening arc. Now this arc form is made of such material and so proportioned that its electrical resistance to a current traversing it is proportional to the length of arc included between the point of the dial and that part of the arc having contact with a member

of the bridge. This resistance that is made to interpose is commensurate with an angle whose sides are the dial itself and the line drawn from the pivot of the dial to the point where the arc form comes in contact with the adject member of the bridge.

An observer, then, stationed at the galvanometer, and at one of the points of resistance can, by noting the galvanometer and adjusting the resistance in the usual way, determine the resistance equiliberating any position of the arm along the arc and so discover the angle of adjustment of the arc; or, having adjusted one of the points of resistance at some given figure, the observer may, by simply noting the galvanometer or any other suitable indicating device, visible or audible, determine when the dial is placed at a desired angle corresponding to the adjusted resistance, and this indicating device is obviously at the place where the moving arm is situated, so that the operator then knows when he has placed the arm at the predetermined point or at the distant station, so that the operator in charge of the resistance point can know that the arm has been properly adjusted; or two indicating devices in the same circuit may give warning to both operators, as above, simultaneously. By this means the elevation or training of a gun may thus be determined or recognised from a distant point, the longitudinal axis of the gun corresponding to the dial in the arc form.

ON THE ELECTRICAL CONDUCTIVITY OF THE EIFFEL TOWER AND OF ITS EARTH PLATES.

By M. A. TERQUEM.

As the Eiffel Tower is the first erection made of iron on such a vast scale as to height, and as, on account of its form, it must be considerably influenced by atmospheric electricity, I thought it would be interesting to ascertain, by exact measurements, the conditions of its conductivity and of its connection with the earth. The tower is furnished with nine lightning conductors, surmounted by a cluster of points, and connected directly with the iron framework which acts as conductor; it was thought that this framework, held together by innumerable rivets inserted whilst hot, the various parts being united with very great pressure, would form a mass that would conduct quite as well as the usual solderings.

The earth plates, which are intended to ensure connection with the earth, are eight in number, two to each pillar; for the north and west pillars, these are cast-iron tubes, 20 centimetres in diameter, descending vertically to about 12 metres below the surface of the earth; for the east and west pillars they are large tubes, 50 c.m. in diameter, descending vertically at first and then turning off at right angles for an average length of 18 m.; they are buried in the alluvium of the Seine, to a depth of 26 m. At present the earth connections are fastened to the tower by iron cables and bands of hoop-iron fastened to the framework.

We used first, for the measurement of the conductivities, a Wheatstone bridge, constructed by M. Gaiffe for the testing of lightning conductors of powder magazines; the second time, we used as well another apparatus made by the same constructor, furnished with a reflecting galvanometer of the Deprez-d'Arsonval type, which allows of Mance's method being used. The determination of the resistance of an earth plate requires three experiments and two auxiliary earth plates, the sum of the resistances being measured in couples. The three unknown quantities are given by three equations of the first degree.

In this particular case it was sufficient to combine in pairs the earth plates of the tower itself.

In order to measure the conductivity of the tower the electric light cable was first insulated from the apparatus and put into communication with the base of the central lightning rod; the end of the cable and a portion of the framework of the western pillar were then connected with the two terminals of the bridge, the tower closing the circuit. The resistance, which was measured several times, was found to be equal, as far as the approximations of the instruments went, to the resistance of the cables which had served as connections. The resistance of the tower may therefore be disregarded.

In order to measure the resistance of the earth connections they were insulated from the tower in the east, south and west pillars, and we obtained for three of them:—

E_1	...	...	...	·3 ω
S_1	...	...	...	·3
O_1	...	...	...	3·2

In the second series of experiments we insulated the earth connections, N_1 and N_2, of the north pillar, taking as the third earth point, E, the base of the tower at the east pillar. The bridge method with the first Gaiffe apparatus, and the Mance method with the second apparatus, gave:—

E	...	·1 ω	...	E	...	·15 ω
N_1	...	·09	...	N_1	...	1·05
N_2	...	1·1	...	N_2	...	1·35

For the Mance method the battery employed was composed of two elements of acid sulphate of bioxide of mercury, a very constant battery, the resistance being only 1·9 ω.

Lastly, we insulated the earth connection, E_1, of the eastern pillar, comparing it with those of the northern pillar; the experiments gave:—

E_1	...	...	...	·2 ω
N_1	...	...	...	1·1
N_2	...	...	...	1·3

It seems that it may be concluded from these experiments, the one being made two months after the other, under conditions that were varied as to method and instruments, that the agreement of the results obtained is a strong argument in favour of their accuracy.

The tower itself must be considered as an assemblage of iron beams in perfect contact with one another, forming a conductor of inappreciable resistance; its connection with the earth, by means of eight earth connections and by canalisations is excellent, since the resistance has been found to be only ·1 ω or ·15 ω at the most for a single pillar. The earth connections of the east and south pillars, which offer a very large surface buried in the alluvium of the Seine, have very little resistance, ·3 ω; as to those of the north and west pillars, if their resistance is higher, 1·1 ω and 3·2 ω, it is no doubt because they have much less surface, and because they pass through the concrete forming the foundations of the tower. In short, we think that the system of lightning conductors on the Eiffel Tower, carried out from the instructions of Messrs. Becquerel, Berger, and Mascart, may be considered perfect, and that it is calculated to extend its protection over a considerable radius.—*Comptes Rendus.*

ELECTRIC LIGHTING AT THE BRITISH MUSEUM.

A FEW months ago the British Museum authorities decided to throw open until 10 p.m. those galleries in that institution which are at present closed several hours earlier, the object of the extension of time being to allow of those engaged in business until late in the evening paying a visit to the Museum, which, under the existing state of affairs, they are unable to do. For this purpose it was necessary that the electric light installation should be augmented, and the extension

has now nearly been completed. In order to give a correct description of the installation as it now exists, it will be essential to refer briefly to the machinery formerly employed. The electric light was first introduced into the reading room of the Museum about four years ago, and it proved to be so successful, and of such great benefit to the readers, that the authorities decided to gradually extend the light throughout the building. A pair of Marshall horizontal engines, having the crank shaft and fly wheel in common, was installed, steam being supplied from two Lancashire boilers, worked at 60 lbs. pressure, but tested to 80 lbs. With 60 lbs. boiler pressure, each engine gave 90 H.P., and with 80 lbs., 120 H.P. The engines are each of 30 N.H.P., and the boiler power was considered to be sufficient for the ultimate extension of the light throughout the whole of the Museum. The power is transmitted from the fly wheel by means of a double leather belt to a pulley on the counter shaft, which is 40 feet long, and from which, by means of pulleys, the dynamos were driven. The latter comprised four Siemens S.D.2 machines, one of which was a spare machine; two Siemens alternating current machines with their exciting dynamos, and one S.D.0 Siemens dynamo. These seven machines supplied current to five 3,000 C.P. arc lamps installed in the reading room, to sixteen 450 C.P. differential arc lamps placed partly in front of the Museum, partly in the hall, and partly on the staircase, and in two or three of the galleries; and to 220 16-C.P. glow lamps, distributed in small numbers throughout the students' rooms, officers' studies, secretaries' offices, &c. The section of the conductors was made about six times larger than was necessary, this having been done in order to ensure the greatest safety possible against fire, owing to the valuable contents of the Museum. The wires were, as far as possible, carried outside the building in wooden troughing, but those in the institution were not bedded into the wall, so that the wire was everywhere readily accessible.

Now, however, in view of a larger amount of electrical energy being required for the additional lamps which will illuminate those portions of the building hitherto closed early in the evening, several alterations in the electrical machinery have had to be made. The five dynamos and two alternators, together with their exciters, have been displaced, and four large Siemens dynamos have been substituted. Each of these has an output of 450 ampères at 130 volts pressure, running at 570 revolutions per minute. Only two of these dynamos are at present in operation, they being driven by the previously mentioned pair of engines. The other two dynamos will be actuated by another pair of Marshall engines, which are now in course of erection, and which will be of about 230 H.P. The Lancashire boilers already installed will supply sufficient steam-power for both pairs of engines, so that no other boilers will be necessary. On the switchboard, which is made of wood, are fixed four Siemens ammeters and one voltmeter by the same firm. There are, in all, six circuits, and four main switches for connecting the dynamos in parallel. For this purpose there are four other switches for closing the shunt coils of the machines, and there are also four German silver resistance coils, for regulating the pressure. The new lamps which have been put up comprise 124 arcs, varying from 6 to 15 ampères, and 850 glow lamps of 16 C.P. The arc lamps, which are run two in series parallel, are installed principally in the lower galleries, whilst the incandescent lamps, which are in parallel, are chiefly placed in the vase and bronze rooms, and in the other upper rooms. A local switch is provided for every two arc lamps, and for every group of from 30 to 40 glow lamps. The 21 arc and 220 incandescent lamps belonging to the old installation still remain, and are supplied with current from two of the new dynamos. The authorities of the Museum propose to keep open all the public galleries until 10 p.m., as already stated, from the 1st January next; but the reading room will, as usual, be closed at 8 p.m.

ELECTRIC TRAIN LIGHTING.

WE have had forwarded to us the following :—

Extract from the "Railroad Gazette" of New York, November 1st, 1889.

The Boston and Albany has abandoned its experiment in electric train lighting. The trial was on two full trains and has been continued for two years and a half. It has been instructive and valuable as an experiment, and, therefore, was praiseworthy; but the great expense was apparently too heavy a burden. The shutting-down of the electric lighting systems in New York, and the consequent inability to have the storage batteries charged at that end of the line, together with the occasional failure of the lights to burn satisfactorily, finally decided the Company to discontinue them, at least until some more satisfactory and economical method of using them is discovered. The trains which have been electrically lighted are to be fitted with the Pintsch gas lighting system. Wagner cars using the Pintsch system are now running to Boston over the Boston and Albany, so that this announcement implies, we suppose, the establishment of a Pintsch plant at Boston, though the New York cars can be charged at the New York Central yards in New York.

It would appear that the above has been printed upon a slip of pasteboard and circulated to the several railway companies, their officials, and others who may be supposed to have been impressed with the fact that the electric light in railway trains is *un fait accompli*. It is not difficult to realise the source from which it emanates. We are sorry we cannot compliment the authors on their taste in their selection of the mode in which they have sought to inform the railway official mind of that of which the authors may rely upon it railway companies are quite as well acquainted with, as are Messrs. Pintsch or anyone else. Nor can we compliment the authors upon their honesty of purpose. This piece of pasteboard is intended to inform railway companies that the electric light, as an illuminant for railway trains, has failed—failed from more causes than one—and that Pintsch is the happy rescuer come to the relief of the poor railway official! Whatever may be doing in America, we know that in England the electric light, as so applied, has not failed; that it has, so far, met the utmost demands of railway traffic; that for some years it has been in use between London and Brighton, and that for many months it has been in operation on the Midland in such a manner, and under such circumstances, as has amply proved its applicability to the purpose. This, no doubt, is pretty well known to the authors of the pasteboard slip, and has, probably, been in no small way instrumental in inducing them to thus show their hand. We would, however, like to suggest to them that in future, when addressing English railway companies, they should adhere to the old English custom of signing their circulars.

To the railway companies we would say: The circulation of the extract you have received shows to what an extent the gas interest feels itself affected by the experiments you are so successfully conducting. Pursue those experiments still further. The gas interest would not go to the expense of circulating such an extract as that above—the value of which is probably that of the paper upon which it is printed—unless they saw that the electric light had already become a successful competitor. It would be a constant source of regret to any board to feel, after having gone to the cost of installing gas, they must, in order to meet the demands of their patrons and of competition, replace it by the electric light!

An ex-Mayor on "Deputations."—A proposal to vote the cost of a deputation of Bradford in connection with the contemplated electric lighting of Southport encountered some lively opposition in the Town Council, especially from the ex-Mayor, who considers, not unreasonably, that these so-called deputations are only picnics, excursions, and holiday-makings in the guise of business. Some "warm comments" were elicited from the other side, and it was urged that a large amount of valuable information had been obtained by the deputation which would far outbalance the cost of the "excursion."

ON THE HEATING OF CONDUCTORS BY ELECTRIC CURRENTS.

By A. E. KENNELLY.

II.

THE accompanying diagram, fig. 4, shows the curves obtained by freely connecting the plotted observations resulting from the whole series of panel measurements. The ordinates represent the temperature elevations and the abscissæ are the current strengths to which those temperature elevations are due. Of the three connected variables, diameter, current strength and rise of temperature, this figure most clearly indicates the relation between temperature and current, while the influence of diameter may be deferred for the moment. It is seen that, generally speaking, the temperature elevation varies as the square of the current strength for any given wire. This would be, perhaps, rigorously true if the resistance of the wire did not increase with temperature, if the conductivity of the panel remained constant, if the space between the wire and the panel walls were filled with solid material, and, finally, if the exterior surface of the panel were maintained at the temperature of surrounding bodies. Under existing conditions the wire generates heat—owing to its rising resistance—faster than the square of the current; while, on the other hand, radiation and convection from the external surface are more than proportionally active as the temperature rises, the two deviations thus counteracting to some extent. So that while the above law cannot be expected to apply accurately, the observations show the departures from it are not so great as to make the rule practically unserviceable. For diameters below 0·10 inch (0·25 centimetre) the temperature elevation appears to have risen more slowly than the square of the current, while for diameters above 0·30 inch (0·76 centimetre) the opposite tendency is shown.

On plotting the results of fig. 4 in such a manner as to elicit the dependence of temperature elevation on diameter alone for constant current strengths, the curves so obtained have not been identified with any simple algebraic law; in fact, the conditions are of so complex a nature as to afford little hope of a simple, yet rigorous, law applying. The loss of heat is taking place first by conduction through the insulating covering of the wire; then by conduction, convection, and radiation through the enclosed air space; next by conduction through the woodwork, and, finally, into the floor or wall to which the panel is fixed, while radiation and convection carry off the heat from the free surface exposed to the air. Even under the simplest conditions that can be imposed in imagination upon the panel, such as cylindrical form with free access of air all round, and a tight fit upon the wire at the axis, the law of temperature increase with diameter for constant currents would involve the ratio of the panel diameter to the wire's diameter logarithmically, and the various dissymmetrical but practical conditions can only serve to make the law more complicated. In the absence, then, of any simple rigorous law, it becomes necessary to select some particular temperature elevation as the safe limit which a wire can be allowed to reach under ordinary conditions, and then to find the best empirical rule which shall approximate as nearly as may be needed to the curve of experimental results.

The rule recommended by the Committee of the London Institution of Electrical Engineers for the prevention of fire risks in electric lighting, as published last year, was that: "The conductivity and sectional area of any conductor should be so proportioned to the work it has to do, that if double the current proposed be sent through it, the temperature of such conductor shall not exceed 150° Fahr." With this rule as a guide, the only remaining question is the normal temperature of the wires from which the rise is assumed to take place. A cellar in winter time might have a temperature of 40° Fahr. (4·5° Centigrade), while near the ceiling of an artificially warmed room the thermometer might reach 100° Fahr. (38° Centigrade). As it would be out of the question to design every wire in a house for the exact temperature it might normally possess at different portions of its length, a fair mean temperature must be selected, from which all elevations can be reckoned. This mean temperature may be taken at 75° Fahr. (24° Centigrade). This being admitted, the rule above-mentioned requires that the temperature elevation of any wire shall not, with double the proposed current, exceed 75° Fahr., *i.e.*, reach above 150° Fahr. (41·7° Centigrade), and it has been seen that this is, for practical purposes, equivalent to the statement that the proposed current shall not produce an elevation of one-fourth that amount (10·4° Centigrade).

TABLE I.

Ampères.	Minimum safe diameter of copper wire.		Circular mils per ampère.	Fall of potential in wire at full load.	
	Inches.	Cms.		Volts per foot.	Volts per metre.
1	0·015	0·038	225	0·0503	0·165
5	0·043	0·109	370	0·0305	0·100
10	0·069	0·175	480	0·0237	0·0777
15	0·090	0·229	540	0·0208	0·0681
20	0·109	0·277	590	0·0189	0·0621
25	0·126	0·320	640	0·0177	0·0581
30	0·142	0·361	670	0·0167	0·0548
35	0·158	0·401	710	0·0158	0·0518
40	0·172	0·437	740	0·0152	0·0499
45	0·186	0·472	770	0·0147	0·0481
50	0·200	0·508	800	0·0141	0·0461
55	0·213	0·541	825	0·0136	0·0447
60	0·225	0·572	845	0·0133	0·0437
65	0·238	0·605	870	0·0129	0·0423
70	0·250	0·635	890	0·0126	0·0413
75	0·262	0·655	915	0·0123	0·0403
80	0·274	0·696	940	0·0120	0·0393
85	0·285	0·724	960	0·0118	0·0386
90	0·296	0·752	970	0·0116	0·0379
95	0·307	0·780	990	0·0113	0·0372
100	0·318	0·808	1010	0·0111	0·0365
110	0·339	0·861	1040	0·0108	0·0353
120	0·358	0·909	1070	0·0105	0·0346
130	0·377	0·958	1090	0·0103	0·0337
140	0·396	1·01	1120	0·0099	0·0327
150	0·415	1·05	1150	0·00975	0·0320
175	0·461	1·17	1210	0·00929	0·0305
200	0·504	1·28	1270	0·00887	0·0291
225	0·545	1·38	1320	0·00853	0·0280
250	0·585	1·49	1370	0·00817	0·0268
275	0·623	1·58	1410	0·00798	0·0262
300	0·660	1·68	1450	0·00771	0·0253
325	0·697	1·77	1490	0·00753	0·0247
350	0·732	1·86	1530	0·00734	0·0241
375	0·766	1·95	1570	0·00716	0·0235
400	0·800	2·03	1600	0·00714	0·0231
425	0·832	2·11	1630	0·00692	0·0227
450	0·865	2·20	1660	0·00674	0·0221
475	0·897	2·28	1690	0·00665	0·0218
500	0·928	2·36	1720	0·00652	0·0214
550	0·988	2·51	1775	0·00634	0·0208
600	1·049	2·66	1840	0·00616	0·0202
700	1·16	2·95	1920	0·00585	0·0192
800	1·27	3·23	2020	0·00558	0·0133
900	1·37	3·48	2080	0·00539	0·0177
1000	1·47	3·73	2160	0·00521	0·0171

DATA: Insulated house wires carrying continuous currents, and encased in wooden panelling. Copper resistivity: 1·650 microhms at 0° C. = 1·870 microhms at 34° C. assumed temperature of full load. Conductivity allowed 98 per cent.

Fig. 5 shows the general results arranged for the purpose of directly indicating the observed dependence of current strength and diameter for any given temperature elevation. Taking for granted that the 10° Centigrade elevation is that which prescribes the safety limit as above, then the empirical formula which shall best represent the 10° curve will form the rule by which the safe diameters of panelled wires may be determined. For the 10° C. curve itself it is difficult to find a simple equation, but for the broken line curve near it, — — —, which follows the current whose double raised the temperature 40° C., the equation:

Limiting current in ampères = 560 (diameter of wire in inches)$^{\frac{3}{2}}$, is seen to be closely applicable except for very small wires, the curve —— · —— — —, in conjunction, being the strict locus of this equation.

This formula makes the small wires rather larger than experiment has shown they need be, but it will be seen that even then they are much smaller than the Board of Trade rule requires.

The following are then the proposed formulæ for determining the limiting safe currents and diameters for insulated copper wires in wooden panels :

$$C = 560 \quad d^{\frac{3}{2}}, \text{ if } d \text{ be expressed in inches;}$$
$$= 0{\cdot}01775\ d^{\frac{3}{2}}, \text{ if } d \text{ " " " mils;}$$
$$= 138 \quad d^{\frac{3}{2}}, \text{ if } d \text{ " " " centimetres;}$$
$$= 4{\cdot}375\ d^{2}, \text{ if } d \text{ " " " millimetres.}$$

And reciprocally,

$$d = 0{\cdot}0147\ C^{\frac{2}{3}}, \text{ if } d \text{ be expressed in inches;}$$
$$= 14{\cdot}7 \quad C^{\frac{2}{3}}, \text{ if } d \text{ " " " mils;}$$
$$= 0{\cdot}0374\ C^{\frac{2}{3}}, \text{ if } d \text{ " " " centimetres:}$$
$$= 0{\cdot}374\ C^{\frac{2}{3}}, \text{ if } d \text{ " " " millimetres.}$$

For ordinary purposes it is convenient to remember that when d is expressed in inches and C in ampères,

$$d = \frac{\sqrt[3]{C^2}}{70}.$$

For the same reason, when the space occupied by the wires is no object, there is always an economical limit to the size of the main in any house installation, for if the fall of potential permissible in them reduces their selection to pure considerations of safety, then it will always be more economical to subdivide the conductors for heavy currents. For example, if 500 ampères have to be carried at full load, the table indicates a main of 0·928 inches (2·36 centimetres) in diameter. But by taking two equal mains, each carrying 250 ampères, their diameters will be 0·585 inches (1·49 centimetres), and the weight of copper will be reduced rather more than 20 per cent.; and in all cases whenever 20 per cent. of the cost of copper necessary for one main will more than cover the expense of another insulating covering and panelling for the second wire, there being no independent objections, it will be economical to divide the conductor.

This remark is, of course, not merely a deduction from the table, nor in any way implicated with the limiting temperatures on which it is based, but is

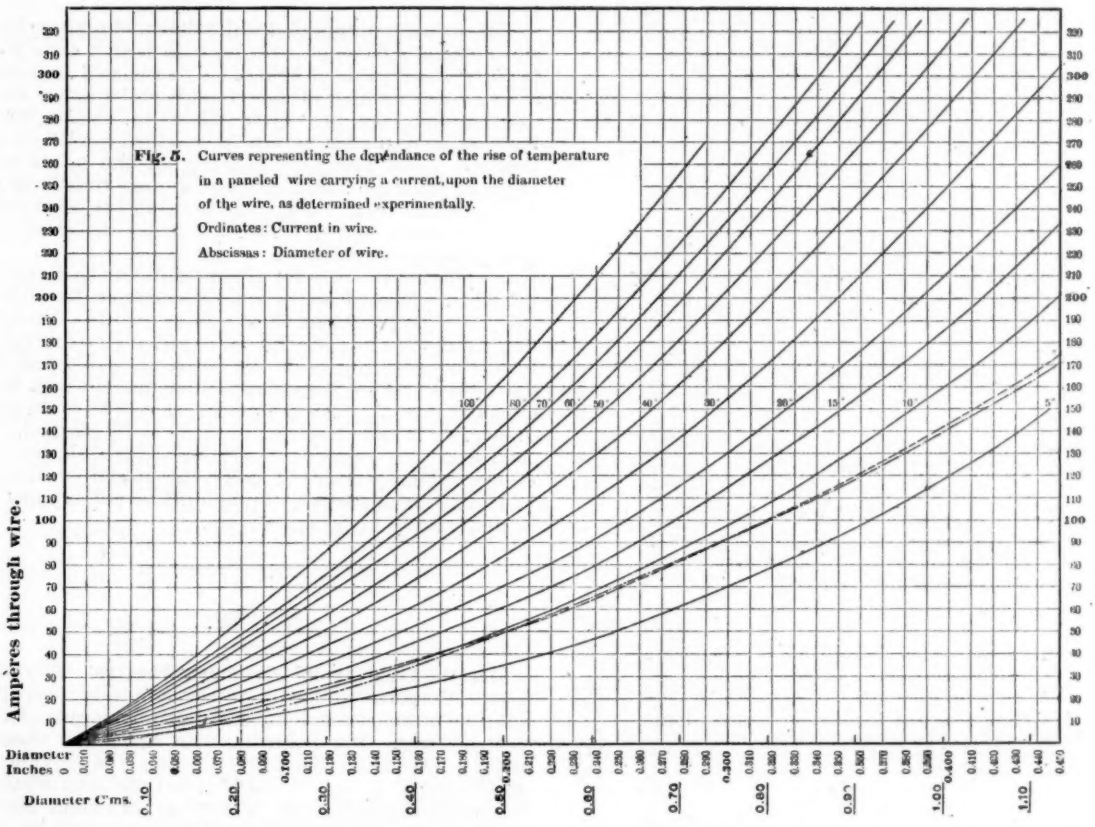


Fig. 5. Curves representing the dependance of the rise of temperature in a paneled wire carrying a current, upon the diameter of the wire, as determined experimentally.
Ordinates: Current in wire.
Abscissas: Diameter of wire.

From these data we have Table I, giving in inches and centimetres, the diameter of insulated copper wire necessary for any specified current.

This table shows that whatever temperature elevation might be adopted as the safety limit, the principle of fixing upon the diameters of conductors by allowing a certain number of ampères to the square inch, or a certain number of circular mils to the ampère, can only be very imperfect unless a sliding scale be arranged. Thus the diameter of wire which coincides with the Board of Trade limit of 1,000 ampères per square inch is 0·504 inch for 200 ampères. According to the table, that rule would not be safe for wires above that diameter, while for wires beneath that diameter it would, in respect to safety, be very uneconomical. Thus to carry 400 ampères at 1,000 ampères per square inch requires 508,000 circular mils; or a diameter of 0·713 inch, while the table indicates 0·800 inch; and, on the other hand, to carry 40 ampères the same rule calls for 0·225 inch, the table showing only 0·172 inch to be necessary.

founded on the fact that when a wire's diameter is doubled; although it takes twice as strong a current to develop the same heat as before per unit volume, there will be four times as much total heat and only twice as much surface through which that heat has to find egress.

Referring to the general curve sheet, certain deductions may be made from it concerning the effect of the nature and thickness of insulating covering, and also the influence of the panel dimensions.

The evidence is distinct that with all the wires tested, and which had the usual thickness of insulating covering [about 0·050 inch (0·13 centimetre) for the small and large wires, with about 0·035 inch (0·09 centimetre) for the intermediate sizes], the effect of the insulation covering was to cool the wire. Thus curves Nos. XIV., XVI., and XVIII., fig. 4, represent the observations on bare copper wires, and show that their temperature elevations were fully 30 per cent. in excess of that found in covered wires of equal diameter and load. Again, curve No. VIII. refers to a kerite wire

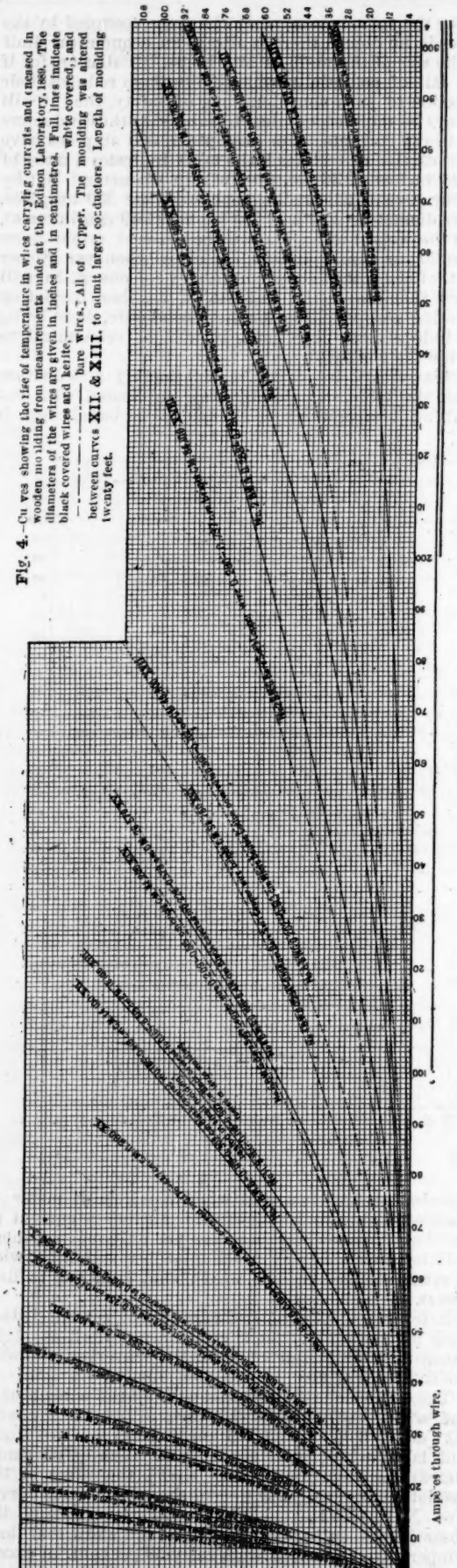


Fig. 4.—Curves showing the rise of temperature in wires carrying currents and encased in wooden moulding from measurements made at the Edison Laboratory, 1889. The diameters of the wires are given in inches and in centimetres. Full lines indicate black covered wires and kerite, — — — — — — white covered, and — · — · — · — bare wires. All of copper. The moulding was altered between curves **XII. & XIII.** to admit larger conductors. Length of moulding twenty feet.

whose coating was 0·073 (0·185 cm.) inch thick. Its temperature elevation is seen to have been about 30 per cent. lower than that obtained with a wire of the same diameter but only covered to a thickness of 0·011 inch (0·028 cm.), No. VII.

As regards the surface nature of the insulating material, curves Nos. IX. and X. represent the behaviour of two wires whose diameters and thickness of insulation were practically equal. No. IX. was double covered with white cotton; No. X. single covered with blackened cotton. All the ordinary insulated house wires were covered at the Edison Machine Works, Schenectady, N.Y., with cotton soaked in a special insulating liquid. The temperature elevation of the latter was about 4 per cent. the lower, and while it is possible that this difference may have been due to the superior radiating power of the black coating, it is not sufficiently marked to be more than a possibility.

Curves Nos. XII. and XIII. show the temperature elevations of the same length of wire first in the smaller panelling and then in the larger. In the latter case there is a cooling effect visible, amounting to 10 per cent.

The conclusion rests that while the exact temperature elevations of a panelled wire depends upon a variety of factors, it is capable of being fairly estimated from the average of a number of experiments under actual conditions, and care has been taken to obtain these measurements under as nearly practical conditions as possible. The mean conductivity of the wires was about 99 per cent.; that is to say, a mean resistivity of 1,640 absolute legal units. The temperature coefficient has been taken at $1 + 0{\cdot}00388t$, t being the elevation in degrees Centigrade.

In applying the rule for safety limitation as given by the table, insulated wires are, of course, to be understood, and no particular thickness or quality of insulation need then be specified. For although extra thick insulating covering cools the wire, it would not be desirable to render it specially thick merely with that object in view. Also each wire should have its own groove, or, if several wires are in the same channel, the total area and surface of the woodwork should be correspondingly large. Finally, the panelling should be run as far as possible through places not exposed to an abnormally high temperature.

NOTES.

Electric Lighting of Plymouth Theatre.—The Plymouth Corporation has granted permission for the lighting of the theatre in that town by means of the electric light. Mr. Balmain, who holds the theatre under a lease from the Council, intends to provide an installation at a cost of £3,000, and the municipality has undertaken the cost of various structural alterations which, while being rendered necessary by the new system of lighting, are considered desirable in order to provide free access to the stage in case of fire. The Council reserves the right of purchasing the installation at the end of Mr. Balmain's lease.

The Lighting of Steamers.—We learn that Mr. R. D. Smellie, M.I.E.E., of West Regent Street, Glasgow, and sometime electrician to Messrs. William Denny and Brothers, Leven Shipyard, Dumbarton, has secured the contract for the electric lighting of four steamers now being built for the "Moss Line." With these, we understand that Mr. Smellie will have completed the electric lighting of no fewer than 51 steamers.

Electric Lighting at Leamington.—Messrs. Rooper and Toser, the well-known contractors of Stafford, have erected an arc lamp on the Parade at Leamington for the Midland Electric Light and Power Company. It is a Brockie-Pell 2,000 candle-power nominal, and is said to be remarkably steady, and of great brilliancy. The cost of the current is about 2½d. per hour.

Electric Light Posts and Wires at Exeter.—The question of the danger arising from electric light posts and wires engaged the attention of the Exeter Town Council at their last meeting, when joint reports on the subject, from the City Surveyor and the Superintendent of the Fire Brigade, were presented by the General Purposes Committee. They enumerated "The difficulties that the cables and wires offer to the possible operations of the Fire Brigade and the police in manipulating the fire escape, either for life-saving or for enabling the men to approach a fire." After considerable discussion the Council confirmed the action of the committee in requesting the Exeter Electric Light Company to place cut-outs or switches on their system at convenient intervals in the High Street and at the head of every diverging street in which the company's wires are placed, such cut-out or switch to be under the control of the superintendent of the Fire Brigade, so that in the event of a fire he may be able to sever the connection with the street in which the fire may be, without further interference with the company's supply to other parts of the city.

Insurance and Lighting—Electric Light the Safest.—The Guardian Assurance Company have just sent out to their policy-holders a special notice with reference to electric lighting, with regard to which the directors some time ago brought out a set of rules to be observed in the installation of electric lighting within buildings. The notice concludes as follows:—"When properly installed, the electric light is regarded by this company as the safest method of lighting."

The Electric Lighting of New York Harbour.—The recent experimental lighting of the Gedney Channel approach to New York Harbour, by means of buoys and electricity, has, we learn on the authority of Captain Mills, of the U.S. Lighthouse Board, been a practical success. During the nine months of trial they have withstood some heavy seas, and on one occasion a buoy was run down without having its light put out. The lamps are of the incandescent type, the current being supplied to them by cables, the earth being used as a return wire.

Cambridge and the Electric Light.—At a meeting of the Cambridge Town Council last Thursday week, it was resolved to apply for a provisional order.

Electric Lighting at Milan.—At Milan, in the principal thoroughfares, the arc lights are placed in the centre of the roadway, the wires leading to them underground. The results obtained are said to be very satisfactory, and the effect of the lighting to be extremely fine.

Municipal Lighting in Saxony.—The authorities at Hanover have decided to erect a central electric light station in that town, and have appointed a committee to enquire into the best means of carrying it out.

New Cable.—The cable now being manufactured by the Telegraph Construction and Maintenance Company is for duplicating the New Zealand section.

Electric Light at Montevideo.—The Compania Nacional de Luz Electrica of Montevideo has lately erected a central electric light station in that town. There are employed five Belleville boilers, each of 300 H.P., supplying steam to eight 150 H.P. engines, coupled direct to Zipernowsky alternating current dynamos. The station has a capacity for 15,000 16 candle-power incandescent lamps.

Electric Lighting at Königsberg.—The electric lighting of Königsberg by underground wires meets with opposition from the Telegraph authorities. The latter not only would hold the city responsible for any damage to telegraphic lines, but seek to impose upon it the condition that within a certain distance of the telegraph wires the electric wires shall be packed in strong iron tubing.

The Lighting of the Tay Bridge.—The Dundee Harbour Trustees, after repeatedly calling upon the North British Railway Company to comply with the Tay Bridge Act, which provides for the lighting of the bridge, have recently taken proceedings in the Court of Session to enforce compliance. At the instance of the company a conference has been held at which the company stated its reasons for not lighting the bridge, and the matter is to be referred to the Board of Trade, the proceedings in the Court of Session being stayed provisionally.

Electric Light Tender Wanted.—For fixing the electric light complete to three rolling mills (ironworks), one drawing mill, one galvanising mill, two forges, at Hadley. Apply for particulars to the Shropshire Iron Company, Limited, Hadley, Wellington, Salop.

Lighting the Suffolk Fat Cattle Club.—The first Christmas show of the new Suffolk Fat Cattle Club commenced at Ipswich on Monday morning. It may be mentioned that the lighting of the hall is by large incandescent lamps, with an aggregate power of about 10,000 candles, for the supply of which the engine at Messrs. Wrinch and Son's factory drives a 30 kilowatt dynamo. This important feature in the arrangements was well carried out by Mr. W. B. Sisling, the Ipswich representative of Messrs. Laurence, Paris and Scott.

Electric Light in Bath.—The laying of the wires for the lighting of the City is progressing very satisfactorily.

Glasgow and the Electric Light.—At a special meeting of the Glasgow Town Council, on Monday, it was agreed unanimously "that an application be made during the ensuing session of Parliament to the Board of Trade for a provisional order, and to Parliament by a Parliamentary Bill for an act to authorise the Lord Provost, Magistrates, and Council, to provide for the supply of electricity for public and private purposes, within the area comprised within the municipal boundaries of the City."

Dover will Apply for the Light.—The Town Council decided on Tuesday to make application for a provisional order.

New Technical Class.—A class has been formed in connection with the staff of the National Telephone Company, Limited, at Leeds, for the study of telephony and electricity, conducted by Mr. A. L. E. Drummond, the local manager. The first meeting was held on Wednesday evening, November 20th, 1889, when Mr. J. C. Chambers, M.I.E.E., general manager of the Yorkshire district, gave the inaugural address. This was followod by Mr. Drummond's lecture, dealing principally with the Leclanché cell, its formation, uses, and connection with the telephone. The following Tuesday the lectures were continued, Mr. Drummond taking the "Blake transmitter" for his text. The third lecture treated principally of magnetism, and was accompanied by various experiments, and illustrations by means of the optical lantern. The lectures, which are to be continued each Tuesday evening throughout the winter months, are well appreciated by the staff, about 30 or 40 being present at the first lecture, which attendance has been kept up.

New Work on Telegraphy.—Messrs. C. Grawinkel and Dr. K. Strecker have lately published a manual (Berlin) principally intended for the use of *employés* in the German telegraphs. The treatise commences with a sufficiently clear description of the laws governing electricity and magnetism, and this portion of the work is commendably free from the display of mathematical formulæ which so frequently encumber, from a learner's point of view, works of this nature. A very complete description is given of the various instruments, methods of working, &c., employed in the telegraph system.

Strikes on the Wane.—The gas strike seems to have collapsed, and there is not much to grumble at concerning the quality of the illuminant supplied to South Londoners, and probably in a few days the pressure will once more have resumed its normal condition. Surely the eyes of the British workman are becoming opened, if but slowly, to the fact that his Socialistic leaders grow fat on his credulity, and that whether strikes succeed or fail, they rise in the one case to an eminence which must be, even to them, perfectly bewildering, and in the other they are better off than at the beginning. The poor dupes, however, have little to gain in any case, and, as recent events have shown, everything to lose. When, as the *Times* remarks, these leaders of labour, who, by the way, never take part in the toil against which they so vehemently declaim, have the handling of large sums of money which is accounted for in the loosest possible manner, it seems odd that more of their followers do not themselves become demagogues and so develop a system of spirited competition for the working man's favour. This is probably what it will come to as time goes on, and then strikes will become, more or less, things of the past.

Electrical Regulations in New York.—A telegram from the New York correspondent of the *Standard* on Sunday evening stated that the removal of the wires for the street lights as a public nuisance began the preceding day, promptly upon the removal of the injunction which the companies had temporarily obtained in order to protect their property. Several miles of wire were ruthlessly chopped down, but 80,000 still remained supported on 15,000 poles. The whole system of regulating electrical appliances in the City of New York appears now to be on the point of a complete revolution. The Grand Jury has expressed the opinion that the death of lineman Feeks, and other like casualties were directly due to the practice of stringing electric light conductors upon the same poles with telephone and telegraph wires, and our readers who happened to gaze at an illustration on p. 667 of our last issue will not be much inclined to quibble with the decision of the jury. Only two months ago there were below 14th Street electric light wires upon telephone poles, and in these no fewer than 250 cases of defective insulation were found. The Grand Jury also finds that it was a grave error to entrust such important interests to a board of electrical control having no practical acquaintance with the subject of electricity either theoretical or applied, and the jury believes, from evidence supplied, that the present board has been both negligent and incompetent, and should at the earliest moment be removed, and the control of subways and electric service should be entrusted to competent supervision. It is recommended that subways should be constructed which would include ample space in one tunnel for gas, steam and water pipes, and for wires, traction cables and similar uses, instead of, as at present, allowing each separate interest the exclusive use of a separate part of the street.

The New York correspondent of the *Daily News* telegraphs that many of the streets there were in darkness on Saturday night, the 14th inst., owing to the action of the Public Works Department in cutting down a large number of poles bearing electric lighting wires. The work will be continued until all the dangerous wires have been removed. The only electric lighting company left in operation was Edison's, all of whose wires are underground.

Electrical Plant.—*Nature* states that there has recently been discovered in India a plant with a high degree of electrical power. This is not altogether new; we have frequently heard of electrical plant before, and offers to supply the same will be found in our advertisement columns.

Telephonic Extension in Devon.—Under the supervision of Mr. C. Hooker, the Torquay Superintendent of the Western Counties and South Wales Telephone Company, the telephone is still being extended in South Devon. The company propose to establish exchanges at Buckfastleigh and Ashburton, and also to connect them with the trunk lines and with Totnes, so that the new subscribers will, on the completion of the work, be able to converse with almost all the large towns in the West of England.

Private Enterprise at Devonport.—A start has at length been made in the Three Towns to use the electric light in the place of gas for illuminating purposes, and Messrs. W. J. Corse & Co., manufacturing electricians, have gained the distinction of being the first firm to adopt the new illuminant. The installation was completed last week, and proved a complete success. The current is generated by one of Roper's patent vertical dynamos, which is capable of supplying 16 lamps, each of 25 C.P. The dynamo is worked by one of Griffin's patent high-speed gas engines of 3 H.P. To each group of lamps a switch is provided, so that one part of the shop can be illuminated without the other. The firm intends enlarging the installation by substituting a larger dynamo, capable of supplying 30 lamps. It will be remembered that Messrs. Corse & Co. gained the highest award at the last Polytechnic Exhibition at Falmouth, and favourable notices for their electrical novelties.

China Telegraphs.—The correspondent of the *Standard* says:—"The Tsung-li-Yamen has ratified the Chefoo agreement, under which the Chinese Telegraphs, the Eastern Extension, and the Great Northern Telegraph Companies reduce their tariff for telegrams to and from China to two dollars a word. The foreign companies take over the communications with Hong-Kong, Shanghai, Amoy, and Foochow, and the Chinese take the rest of China. Each company transmits the messages of the others without charge."

The Royal Society.—The following paper was down for reading yesterday by Mr. C. Chree:—"On the Effects of Pressure on the Magnetisation of Cobalt."

Polarised Electric Roads.—Under this heading a correspondent of the *Electrical World* says he has been told that street railroads, operated by electrical power, have been found not to work as efficiently when running north and south as when running east and west. Our contemporary seems disposed to refer the correspondent to the mules for an explanation of the "phenomenon."

Electric Cars in England.—A correspondent of the *Western Electrician* (Chicago) deplores the little enthusiasm shown by the London public for the electric tramcar, although fairly successful in the trial given it. He thinks it will be long before the electricians are able to convince Londoners of the immense advantage of these cars. However, he foresees a time—a distant one, no doubt—when the cars will be run as a practically and firmly established necessity.

Lightning Conductors.—At the meeting of the Greenock Harbour Trust recently, the engineer reported that the lightning conductor of the chimney of Garvel Graving Dock engine-house had broken and fallen to the ground. On examination it was found to have been worn through at the top through rubbing against the projecting cornice at the head of the chimney, and he submitted an offer from Messrs. David Tosh and Son to repair and put up the same for the sum of £5. The committee authorised the acceptance of the tender, the engineer to see that *the conductor was fastened in several places to the chimney by additional insulators!*

Lighting St. James's Hall.—The lesser Hall, occupied by the Moore and Burgess Minstrels, is at present closed, in order to receive an electric light installation.

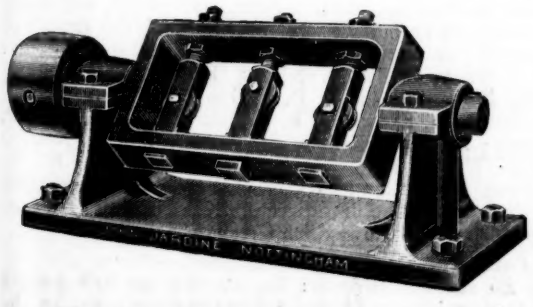
Royal Institution of Great Britain.—We notice the following in the list of probable arrangements for the Friday evening meetings before Easter, 1890, to which members and their friends only are admitted :—Friday, January 24th, Prof. Dewar, M.A., F.R.S., M.R.I., "Scientific Work of Joule." Friday, February 14th, Prof. J. A. Fleming, M.A., D.Sc., M.R.I., "Problems in the Physics of an Electric Lamp." Friday, February 21st, Shelford Bidwell, Esq., M.A., F.R.S., M.R.I., "Magnetic Phenomena." Friday, March 21st, Prof. G. F. Fitzgerald, M.A., F.R.S., "Electro-magnetic Radiation."

Holborn Board of Works and the Central Railway.—At a meeting of the Holborn Board of Works, on Monday, Mr. G. Phillips presiding, the Board's surveyor (Mr. H. H. Isaacs, M.P.), submitted a report dealing with the proposals of the Central London Electric Railway, and in that report the surveyor recommended that no opposition should be offered to the Bill provided that satisfactory clauses were inserted for the protection of subways and footpaths should they be interfered with. The Board decided to have the report printed and circulated among the members, and it will be discussed at the next fortnightly meeting of the Board.

St. Pancras Vestry and Electricity.—In the report of the Highways Committee an application had been considered from the Metropolitan Electric Supply Company for leave to lay 5-inch iron pipes across Tottenham Court Road to connect the electric supply of the parishes of St. Marylebone and St. Giles, instead of opening along the roads leading to the boundaries at the south end of Tottenham Court Road, and the committee do not consider it expedient to grant the privilege desired for several reasons, but chiefly because it would be in excess of the powers conferred by the company's Act of Parliament, and therefore the committee recommended that the application of the Metropolitan Electric Supply Association for leave to lay supply pipes in this parish be not granted, which was adopted. The lighting of the parish then came up for consideration. It was moved by Mr. Westacott that the consideration of the matter be left over until January 1st, when a special meeting should be called. The proposition was agreed to.

Telephonic Communication with a Theatre.—The Empress Frederick's new property at Kronberg is to be placed in telephonic communication with the Opera House at Frankfort, so that Her Majesty will be able to listen to the performances going on on the stage.

Wire Straightening Machine.—The machine here illustrated, manufactured by John Jardine, of Nottingham, is constructed to straighten wire from the coil, of any diameter up to $\frac{3}{8}$ inch, the principal improvement consisting in substituting hardened steel pulleys for solid dies. When solid dies are used they



rapidly wear to a sharp edge, and consequently cut the wire like a screw as it passes through the dies, but steel pulleys do not wear to an edge, and consequently do not mark the wire, although they perfectly straighten it.

Another Death from Electric Light Wires.—The *Standard* correspondent, telegraphing from New York on Wednesday night, sends the following :—"At Toledo, in the State of Ohio, on Tuesday, a glazier was working on a tin roof measuring a skylight, when his sleeve, which was wet with rain, touched the wires which fed the incandescent lamps with an alternating current. The unfortunate man fell dead, in such a position, that his body lay supported by the wires, and was only found by accident some hours after the occurrence, judging from the extent to which the burning had progressed, and by the smoke and odour arising from the clothes and the flesh. Accidents on the incandescent systems disclose a new peril. Hitherto electricians have contended that the so-called "converters" infallibly reduced the strength of the current on the external wires, so that it was impossible any danger could arise within houses or away from the main conductors, which are usually placed out of reach. Apparently, electricians must now revise this theory." We observe that there is a Toledo electric company employing incandescent lamps on the Thomson-Houston alternating system, and arc lamps of both Brush and Thomson-Houston.

Metropolitan Electric Supply Company's Report.—The report of the Metropolitan Electric Supply Company, Limited, we publish this week in full, because the reports of this company and of the London Electric Supply Company must for some time to come be looked to with interest, as showing what can be done commercially with electric light supplied on a large scale. In regard to the present report, very little can, however, be said, as the various stations have been but recently started, and the conditions obtaining hitherto cannot therefore be considered normal. We note, in passing, that so far the cost of the engineering department, working and maintaining stations, rent, rates, taxes, management, directors' fees, and other expenses, total £15,961 3s. 5d. ; on the other hand, the supply of light and power and other income brought in £6,127 5s. 2d. We hope that the next report will prove that this important company is going to demonstrate that electric lighting on a large scale can be made a really first-class investment.

The Dire Opponent of High Tension.—Mr. Harold P. Brown has forwarded us another of his circulars, from which it appears that he is likely to gain a large consulting practice as an electrical engineer. A copy of some tests of the plant of the Manhattan Electric Light Company, made for the Health Department of the City of New York by Dr. Cyrus Edson and Edward Martin, are attached, and we shall perhaps reproduce this in a future issue.

The International Congress of Telegraphy.—The International Congress of Telegraphy will hold its next session at Paris in 1890, under the presidency of the Director-General of Posts and Telegraphs. The last Congress was at Berlin in 1885.

The Southwark Subway Electrical Railway.—We see it announced in yesterday's *Daily Telegraph* that this line is likely to be opened in March next.

The Electrical Engineers of Paris.—Some disappointment is felt that no honorary distinctions have been conferred upon the engineers and others engaged in the recently completed electric lighting of the Halles.

Mechanics' Annuals.—We have received a copy of the Mechanical World Pocket Book and Year Book for 1890, which contains a useful collection of notes and formulæ arranged for the use of engineers, draughtsmen, mechanics, manufacturers, and others. Mr. John Calvert, of Manchester, has also sent us a copy of his excellent Mechanics' Almanack and Workshop Companion for 1890, containing a mass of valuable information of a practical, technical, and industrial character, specially instructive and entertaining to artisans and handicraftsmen.

Electricity in German Railway Stations.—The electric light in the principal railway station in Berlin has been found so greatly superior to any of the systems of gas lighting hitherto tried, that it has been decided to apply it to all other stations.

Electric Lighting Wanted in Manila.—Her Majesty's Consul at Manila, Philippine Islands, has reported to the Secretary of State for Foreign Affairs that the municipality is desirous of obtaining tenders for the lighting of the city and suburbs by electricity, instead of the present system of petroleum lamps. The total distance to be so lighted is about 36 miles, and the time for receiving proposals is limited to a period of six months, dating from the 1st ult. Further details and plans may be seen on application to the Commercial Department of the Foreign Office.

Central Telegraph Staff.—On Tuesday the staff of the Central Telegraph Office held a meeting at the Foresters' Hall, under the presidency of Sir J. H. Puleston, M.P., for the promotion of Civil Service interests.

The Institution of Electrical Engineers.—At the annual general meeting of this Institution, held on the 12th inst., the following gentlemen were announced as the Council for the year 1890:—*President:* J. Hopkinson, M.A., D.Sc., F.R.S. *Vice-Presidents:* William Crookes, F.R.S.; Prof. W. E. Ayrton, F.R.S.; Alexander Siemens; R. E. Crompton, M.Inst.C.E. *Ordinary Members of Council:* Major Philip Cardew, R.E.; W. Lant Carpenter, B.A., B.Sc.; Sir James Douglass, F.R.S.; Sir Douglas Galton, K.C.B., D.C.L., LL.D., F.R.S.; Gisbert Kapp, Assoc. M.Inst. C.E.; Prof. John Perry, M.E., D.Sc., F.R.S.; Sir David Salomons, Bart., M.A.; Prof. Silvanus P. Thompson, B.A., D.Sc., F.R.A.S.; Sir James Anderson; Sir Albert J. Leppoc Cappel, K.C.I.E.; Sir Henry C. Mance, C.I.E., M.Inst. C.E.; Colonel R. Raynsford Jackson. *Associate Members of Council:* Augustus Eden; Sidney Sharp; Francis H. Nalder. *Honorary Treasurer:* Edward Graves. *Honorary Auditors:* Frederick C. Danvers, India Office, S.W.; Augustus Stroh. *Honorary Solicitors:* Messrs. Wilson, Bristows and Carpmael, 1, Copthall Buildings, E.C.

Arc Lamp v. Gas.—During the strike of the gas workers of Manchester, the large butchering establishment of Barker's, Stretford Road, Manchester, was lighted by means of a Richardson arc lamp, which has proved so satisfactory, that it is going to be retained permanently. The current for the lamp is supplied direct from Mr. Richardson's works in the locality.

The Telephone in Japan.—The Mikado has had constructed, at the cost of the State, a line of telephone between Yokohama and Striznoka, a distance of about 100 miles. It is the first telephone applied to the public service in Japan, and has so far been completely successful.

Electric Light at Chelmsford.—It is expected that the circuits for the lighting of the borough will be working in the course of a few days. Messrs. Crompton will not commence the contract with the Corporation until they have thoroughly tested the system.

Steam Tramcars Voted a Nuisance.—A public meeting was held last evening at the Manor House, Finsbury Park, with the view of starting a movement for the abolition of steam tramcars, which are complained of by the residents of Seven Sisters' Road. A committee was formed some time ago for the purpose of making application to the Local Government Board. After considerable discussion, during which electricity was suggested as the best means of obviating the present nuisance, a resolution was passed approving the action of the committee.

A Cook as an Electrical Engineer.—A correspondent of the *Elektrotechnische Anzeiger*, of Berlin, states that he has been staying at a Swiss hotel where 22 incandescent lamps are employed, supplied from a Schuckert dynamo driven by a small turbine. There is nothing remarkable so far, but the writer goes on to say that the dynamo is placed in the kitchen of the hotel, the cook having charge of it. He acquits himself admirably of his double duties as *cordon bleu* and electrical engineer.

The Institute of Marine Engineers.—On the 6th inst. this Institute held a *conversazione* at the Town Hall, Stratford, E., under the presidency of Mr. Asplan Beldam, the President of the Institute. The society was formed for the purpose of discussing all matters pertaining to marine engineering, and for the social and intellectual development of its members. It commenced in a small way two or three years ago, and is now on a firm basis. On the evening in question a small display of articles was made. Bell's Asbestos Company had on view various specimens of their well-known packing, whilst the India-Rubber and Gutta-Percha and Telegraph Works Company, Limited, of Silvertown, exhibited several samples of their telegraph cables, insulating material, India-rubber tubing, &c. The Telegraph Construction and Maintenance Company, Limited, showed a specimen of the cable made by them, and laid between Malta and Tripoli, the cable being arranged so as to show the insulation and protective materials right from the copper to the external covering. Many other articles were on view, including several small marine engines, diagrams, &c.

The London Central Electric Railway.—At a special meeting of the Bartholomew Club on Tuesday evening, Mr. J. Lewis moved:—"That in the opinion of this club, the scheme for introducing the Central London Electric Railway under the principal thoroughfares of the metropolis is both dangerous to the occupiers of premises adjacent, and prejudicial to the great trading interest; while at present there is not sufficient evidence to show that electricity is a source of power to be relied on. Therefore the Corporation be respectfully requested to oppose the scheme in its various stages before Parliament." After discussion the motion was put, being carried *nem. con.* It was further resolved that a copy of the same be sent to the Common Council and the Commissioners of Sewers. Mr. Lewis is evidently unacquainted with the power of electricity which can be relied upon; but the people who attempt to introduce and control such schemes as that which is declared to be both dangerous and prejudicial are not always so certain in their actions.

NEW COMPANIES REGISTERED.

Gas Consumers' Protective Association, Limited.—Capital £1,000, in £1 shares. Objects: The protection of consumers of gas, electric light and power, and water against loss or damage in connection with the supply or consumption thereof. Signatories (with 20 shares each): T. Methley, S. Aubyn's, West Brighton; G. P. Simpson, M.E., 5, Belsize Park Gardens; W. J. Davies, Hornchurch, Essex; C. E. M. Barker, Harold Wood, Essex; R. J. Mackenzie, St. James's Square, Notting Hill; W. C. Galloway, 50, Gresham Street; H. W. Strand, 11, Maitland Park Road, N.W. The signatories are to appoint the first directors. Registered 11th inst. by Burn and Galloway, 50, Gresham Street.

Camborne Gas Company, Limited.—Capital £10,000, in £5 shares. Objects: To manufacture and supply gas, electricity, and other illuminating agent in the town and neighbourhood of Camborne, Cornwall. Signatories (with 1 share each): F. W. Thomas, W. Bailey, T. Shaw Lowry, R. H. Williams, J. R. Daniell, A. A. Richards, Walter Pike, all of Camborne. Directors: Messrs. A. C. P. Willyams, W. Pike, W. Rabling,

H. P. Vivian, F. W. Thomas, and J. Thomas; qualification, £100 in shares; remuneration, until otherwise decided by general meeting, a sum not exceeding £50 per annum. Registered 12th inst. by Messrs. Waterlow Brothers, as agents for Messrs. Daniell and Thomas, Camborne.

North African Gas Syndicate, Limited.—Capital £30,000 in £1 shares. Objects: To carry on in Algeria, and other parts of Northern Africa, the business of a gas company and of electric light company in all branches. To construct and lay down all necessary cables, wires, lines, accumulators, lamps, and works, to generate, distribute, and supply electricity for light, heat, motive power, or otherwise. Signatories (with 1 share each): T. M. MacGeagh, 21, Bedford Place; R. Hutchinson, C.E., M.E., 2, Clyde Street, Kensington; R. M'Lachlan, M.E., and J. G. Piggott, College Hill Chambers, E.C.; H. M. Dunstan, 52, Avenue Road, West Kensington; H. Schalbehir, 13, Stockwell Park Road; C. F. Bentley, 53, Gloucester Road, N. The signatories are to appoint the first directors; qualification, £100 in shares or stock; remuneration, £50 per annum each; and, in addition, £10 per cent. of net profits in any year in which £10 per cent. dividend is paid. Registered 13th inst. by H. C. Eliott, 143, Cannon Street.

Heathley, Janisch and Company, Limited.—Capital, £3,000 in £1 shares. Objects: To trade in chemical and drugs, and in electrical, surgical, and other scientific apparatus. Signatories (with 1 share each): *G. A. Heathley, *Ralph Carr, *W. Turnbull, Mrs. Turnbull, *Mrs. E. Janisch, all of Newcastle-on-Tyne; J. Heathley, Blyth; *E. Towers, Tynemouth. The signatories denoted by an asterisk are the first directors; qualification, £50 in shares or stock; the company in general meeting will determine remuneration. Registered 13th inst. by Messrs. Waterlow and Sons, as agents for Messrs. Watson and Dendry, Newcastle-on-Tyne.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Morris Brothers, Limited (electricians, &c.).—An agreement of 9th inst. between Wm. Richard Morris, of 246, Wheeler Street, Birmingham, and John Thornton, of 139, Great Hampton Street, Birmingham, confirms an agreement of 4th December, which provides for the purchase of the business of Morris Brothers, of the Hartington Works, Brunston Street, Birmingham, together with plant and machinery, for £1,000 in fully paid shares.

Dixon and Corbitt and R. S. Newall and Company, Limited (wire drawers, telegraph, telephone and electric light cable manufacturers).—At an extraordinary meeting of this company, held at the Central Station Hotel, Newcastle-on-Tyne, on the 7th September, a resolution was passed authorising the directors to borrow, not exceeding £50,000, upon the security of the property and assets of the company, and to apply the same toward payment of the purchase moneys or the balance of purchase money due to the vendors under a modification of the agreement of 26th May, 1887. The resolution was confirmed on the 24th September.

The annual return, made up to the 14th October, was filed on the 22nd October. The nominal capital is £120,000, divided into 6,000 ordinary and 6,000 preference shares of £10 each. The whole of the ordinary shares credited as fully paid are taken up; 1,907 preference shares have also been taken, 250 of which are considered fully paid; upon the remaining shares £8 per share has been called, the calls paid amounting to £13,232, and unpaid to £24.

Simplex Electrical Syndicate, Limited.—The annual return of this company, made up to the 1st inst., was filed on the 11th inst. The nominal capital is £6,000, in £50 shares, the whole of which are taken up, and are fully paid.

Electric Construction and Maintenance Company, Limited.—The annual return of this company, made up to the 31st October, was filed 11th ult. The nominal capital is £100,000, in £10 shares. 82 shares only are allotted, and upon these no call has been made or paid.

An order of the Board of Trade (Railway Department), dated 9th inst., sanctions the name of the Company being changed to the Electric Installation and Maintenance Company, Limited, in accordance with the special resolution passed by the shareholders on the 15th ult., and confirmed by them on the 2nd inst. The registration of the change was effected on the 10th inst.

Swan United Electric Light Company, Limited.—The annual return of this Company, made up to the 28th ult., was filed on the 10th inst. The nominal capital is £1,000,000, in £5 shares. The shares taken up are 78,949 ordinary and 19,750 fully paid. Upon the former £3 10s. per share has been called, the calls paid amounting to £279,851 10s. The sum of £3,530 has been paid upon 1,201 shares forfeited.

Blackpool Electric Tramway Company, Limited.—The annual return of this Company, made up to the 12th inst., was filed on the 14th inst. The nominal capital is £30,000, in £10 shares, the whole of which are taken up, 150 being considered fully paid. Upon the remaining 2,850 shares the sum of £6 10s. has been called, the calls paid amounting to £18,521 15s. 6d., and unpaid to £3 4s. 6d.

Taunton Electric Lighting Company, Limited.—At an extraordinary general meeting of the members of this Company, held at the Castle Hotel, Taunton, on the 21st October, it was resolved to increase the capital by creating 2,000 new shares of £5 each, to be offered in the first instance to the shareholders in proportion to their several holdings, and to issue and allot in such other manner as the directors may think expedient all or any of such new shares at such times and at any premium, and generally on such terms and conditions as the directors may determine. The resolution was confirmed on the 5th ult., and together with the notification of increase of capital pursuant to section 11 of 51 Vict., Cap. 8 (Customs and Ireland Revenue Act, 1888), was filed on the 14th inst.

LEGAL.

United Telephone v. Tasker.—Mr. RENSHAW, Q.C., moved, before JUSTICE KAY on Friday, to dismiss the action of the United Telephone Company *v.* Tasker for want of prosecution, on the ground that the plaintiffs had failed to comply with an order for a further and better answer to the interrogatories administered by the defendants. He said the action was brought to restrain an alleged infringement of the Bell Telephone Patent, and the defendants put in a defence and counterclaim for damages, on the ground that the plaintiffs, having made an agreement with the defendants as to supplying them with telephones for the purpose of a telephone exchange at Sheffield, afterwards promoted by a rival company, the National Telephone Company, the setting up of a rival exchange in the same town. In connection with this matter interrogatories were administered, the answers to which had been decided to be insufficient, and on November 20th an order was made that the plaintiffs put in a further and better answer within 14 days. A further affidavit was filed on December 4th, but this, he contended, was also insufficient, and he, therefore, brought the present motion, the real object of which, of course, was not to have the action dismissed, but to have a full and sufficient answer.

Mr. BOUSFIELD having also pointed out the insufficiency of the answer, and urged that the defendants were entitled to bring this motion under Order 21,

Mr. MICKLEHAM, for the plaintiffs, contended that the answer was sufficient.

Mr. JUSTICE KAY decided that the answer was not sufficient; at the same time he exceedingly disapproved of the method which had been adopted for bringing the question before the Court by way of motion, instead of taking out another summons for a better answer. He should, therefore, order a further and better answer within a week, but should not give the applicants their costs.

CITY NOTES, REPORTS, MEETINGS, &c.

The Maxim-Weston Electric Company, Limited (in Liquidation).

THE statutory meeting of this company was held at the Cannon Street Hotel, on Wednesday last, Mr. John Marks in the chair.

The secretary having read the notice convening the meeting, Mr. Boyce, accountant to the liquidators, read the following report of the liquidators :—

"By special resolution of the company, passed 3rd December, 1888, and confirmed 21st December, 1888, it was resolved that the old company should be wound up voluntarily, and the undersigned were appointed liquidators; and by special resolutions, passed 21st December, 1888, and confirmed 7th January, 1889, the liquidators were authorised to enter into an agreement with a new company, to be named the Maxim-Weston Electric Company, Limited, for the sale to such new company of the business and property of the old company. The new company was registered 17th January, 1889, and the liquidators have entered into the agreement with the new company, which was sanctioned by the shareholders of the old company. In pursuance of that agreement, the new company has taken possession of the business and property of the old company, with the exception of certain claims to be hereafter referred to.

"The new company have paid debts and liabilities of the old company and of the liquidators, amounting to £4,180 14s.

"The new company has allotted to shareholders in the old company 262,536 shares of 3s. each in the new company, with 2s. each credited as paid thereon in exchange for shares of the old company.

"Proceedings were taken in the Chancery Division by certain dissentient shareholders in the old company to restrain the liquidators from carrying the reconstruction agreement into effect. These proceedings were compromised upon the new company depositing a sufficient sum to cover the estimated value of the interest of those shareholders. Arbitration proceedings were afterwards instituted between the liquidators and the dissentient shareholders to settle the value of the interest of the latter in the old company. Ultimately the liquidators arranged to pay to the dissentient shareholders 1s. 6d. per share, and the new company have paid on this account the sum of £1,813 14s. 6d.

"Of the 312,000 shares to be allotted to the liquidators or their nominees by the new company 49,464 shares were not applied for by the shareholders of the old company. Of these shares 11,845 have been sold by the liquidators, and have realised the sum of £868 17s. 6d.

"Disputes having arisen between the liquidators and Mr. Hugh Watt, one of the shareholders of the old company, as to the number of shares in the old company to which Mr. Watt was entitled, such disputes were by consent referred to the arbitration of Mr. Frederick Whinney, who awarded :—

'(1) That of the 7,376 shares in the company to which the said Hugh Watt claims to be beneficially entitled, he is so entitled to 4,416. (2) That the said Hugh Watt would be beneficially entitled to 2,710 in the company (further part of the 7,376 shares) if he paid the amount due to the company in respect of such 2,710 shares—*videlicit*, the sum of 5s. per share. (3) That the said Hugh Watt is not entitled to 250 shares in the company, being the remainder of the said 7,376. And he further awarded that the said Hugh Watt do pay to the liquidators the sum of £50 towards their costs of the reference, and that they do pay the balance of their costs thereof, and that the said Hugh Watt do pay his costs of the reference, and that the costs of the award be borne in equal shares by the said parties.'

"In further explanation of this, the liquidators have to state that the share registers had been most imperfectly kept, and were full of errors. Much time was occupied, and much expense necessarily incurred, in unravelling the complications that had arisen, and which turned mainly upon inaccuracies in the accounts of Mr. Watt and his nominees. The liquidators are glad to say that their view of what the condition of Mr. Watt's account ought to have been was fully confirmed by the arbitrator.

"The liquidators regret to state that of the £9,769 19s. 9d. appearing at the date of the liquidation as book debts, and which were nearly all included as good book debts in the 1887 balance-sheet, they have only been successful in recovering £1,143 5s. 3d. This is owing to the fact that many of the accounts were disputed, and a very much smaller sum than that stated in the company's books had to be accepted in order to effect any settlement.

"Other sums had been included as 'book debts,' being the selling price of goods consigned to agents in the colonies and abroad. These goods have not been sold, and it is doubtful if they will pay for bringing them back to this country, having regard to the recent improvements in electrical machinery and appliances.

"The liquidators are also engaged in defending the action brought against the old company by Mr. Watt, and in prosecuting the claim of the company against Mr. Watt for an account of his dealings with the property and affairs of the old company.

"As litigation is now pending in respect of these matters, the liquidators refrain from further comment upon them.

"JOHN MARKS,
"LOUIS SWABY,
"JOHN MATTHEW KLENCK, } *Liquidators.*

The Chairman said the report just read really cut the ground from under his feet as regarded any remarks he might have made to the meeting. On the one question on which he would have liked to say something his mouth was closed; he referred to the litigation pending between Mr. Hugh Watt, on the one hand, and the liquidators on the other. The meeting would have seen that the liquidators had been successful in resisting Mr. Watt's claim to 7,376 shares in the old company. Mr. Watt claimed that number of shares, and also held certificates for that number; but other shareholders also held certificates for the same shares. He (the Chairman) was happy to say that the liquidators had succeeded in convincing the arbitrator that Mr. Watt was entitled to some 3,000 shares less than he claimed. The meeting was merely a formal one, held in compliance with the statute, the liquidation not having been closed within the 12 months of the winding up resolutions passed by the shareholders. Had the pending litigation been settled or not commenced, the liquidators would have wound up long since.

Sir Henry Hoare would like to know what money they had in hand, and the work they were doing with respect to electric lighting. They had all, he believed, paid their calls.

The Chairman said the question related to the new company. The liquidators would be very happy indeed, after the close of the present business, to give any information with regard to the new company; but for that purpose they must hold a new meeting. In reply to a shareholder, he said the liquidators had been informed by their solicitors that the litigation was likely to come on in the early part of the ensuing year. With the conclusion of that litigation, the liquidation would also be at an end. He further stated that no money would be paid to Mr. Watt under the award until the action was settled. Until then the full amount claimed would remain in the bank in the joint names of the respective solicitors. Up to the present no steps had been taken with reference to the 2,700 shares mentioned in the award. In reply to Mr. Newton, he said that if it was the wish of the shareholders the report would be circulated amongst the shareholders of the old company. That had not been done already, the liquidators being desirous of avoiding expense.

Mr. Newton hereupon moved that the report be so circulated.

Sir Henry Hoare thought they ought to be satisfied with the very succinct and reasonable report the liquidators had given them, and not go to further expense for printing, stamping, and circulating. He moved an amendment to that effect.

The Chairman said, with regard to this the liquidators were quite in the hands of the meeting, and, after some further discussion the amendment was put and lost, and the original motion, that the report be printed and distributed to the shareholders of the old company was carried.

On the question of remunerating the liquidators for their services,

Sir Henry Hoare proposed that a vote of remuneration to the liquidators be passed, no amount being named.

The Chairman, in reply to a shareholder, said the question had nothing to do with the cost of the Provisional Committee's investigation, none of that money having passed through the liquidators' hands.

Mr. Klenck explained that the amount awarded to the committee of investigation would come before the new company at its meeting. With reference to the proposal before the meeting, he said the expenses of the liquidators had been necessarily very heavy, and a proper account would be rendered at the right time. Some gentlemen, he had been told, who had promised to contribute to the expenses fund, had not yet done so. He held that the labourer was worthy of his hire. Had he known beforehand the amount of time and trouble connected with this liquidation, he would not have become a liquidator. They had accepted an inheritance of muddle and disaster almost impossible to conceive. He had himself become personally liable in very large amounts in order to assist the liquidation. He thought the meeting should vote a sum of 300 guineas to the liquidators.

The Chairman, in reply to a shareholder, said whatever sum they voted, it would have to be paid out of moneys of the new company.

After some further discussion on the motion of Sir Henry Hoare, it was unanimously agreed that the sum of £157 10s. be paid to the liquidators on account of their remuneration, and with a vote of thanks to the chairman, the meeting dispersed.

The Metropolitan Electric Supply Company, Limited.

THE report of directors to be presented at the second ordinary general meeting states that the directors have satisfaction in submitting the annexed statement of accounts to the 30th September, 1889, and in informing the shareholders of the progress made by the company.

Since the last general meeting important rights have been granted to the company, with the sanction of the Board of Trade, and confirmed by Parliament. Extensive installation works have

been completed, and are now supplying the electric light, and other works of the same character are in progress, and approach completion, for the efficient lighting of the areas assigned to the company. These areas are estimated to include in the aggregate about 35 miles of streets, a large number of which run through some of the wealthiest portions of the Metropolis.

The existing demand for the electric light far exceeds the company's power of supply, even if its authorised capital had been all called up and expended on installation works, and the directors have under their consideration the issue of debentures at a moderate rate of interest, so as to avoid increasing the share capital at present. If, however, the anticipations of the directors are realised, there seems little doubt that the share capital of the company will have to be considerably augmented. The chairman, in the evidence he gave before the Board of Trade enquiry, stated that, if the company were as successful as he expected, its share capital of £500,000 would have to be increased four-fold, and the present prospects of the company, judging from the actual applications for the light recorded in its books, point to this estimate being verified, and to a highly satisfactory dividend being earned.

The largest item of capital expenditure is that incurred upon the erection of the stations which are described in paragraph 10.

Since the last general meeting the Board of Trade, acting under the powers conferred upon that department by the Electric Lighting Acts, have held an official enquiry into the applications by this and other companies for provisional orders and licenses. This enquiry lasted through the month of April, and resulted in a valuable report by Major Marindin, the Board of Trade inspector, wherein he recommended that there should be allotted to this company the following areas:—

Under the Mid-London Order.—The whole of the areas comprised in St. Giles-in-the-Fields; St. George, Bloomsbury; St. Andrew, Holborn-above-Bars; St. George-the-Martyr; St. Sepulchre, Saffron Hill; Hatton Garden; Ely Rents and Ely Place; The Liberty of Glasshouse Yard; St. Anne, Soho; St. Paul, Covent Garden; St. John the Baptist; Savoy, or Precinct of Savoy; St. Mary-le-Strand; St. Clement-Danes and the Liberty of the Rolls; together with the extra parochial places known as the Charter House, Gray's Inn, Lincoln's Inn, Staple Inn, and Furnival's Inn.

Under the West London Order.—The whole of the parish of St. Marylebone.

Under the South London Order.—The whole of the parishes of St. Mary, Lambeth; St. Leonard, Streatham; and Clapham.

Under the Bill.—A portion of the parish of St. Martin-in-the-Fields.

The directors decided not to proceed with the South London order, but propose making a fresh application for it, when they hope to make satisfactory arrangements with the local authorities with whom they were not able to settle terms within the time at their disposal.

A larger portion of St. Martin-in-the-Fields than that recommended was afterwards conceded. The remaining orders were confirmed by Parliament during the last Session.

The result of this legislation has been to give the company the right of supplying electricity within the above-named areas, and if the Board of Trade, to avoid the frequent breaking up of streets and interference with traffic, adhere to the principle laid down, that not more than two companies shall be recommended for each district—one restricted to the use of the alternate current transformer system, and the other to the use of the continuous current system—future competition will be limited.

This principle, valuable in itself and of great service both to this company and the public, could only be upheld after a full and exhaustive enquiry into the means of the various companies, and their proposed methods of supply. This necessarily involved considerable delay and expense, both the London County Council and the local authorities taking part in the enquiry conducted by Major Marindin, and also in the subsequent proceedings before the committees of both Houses of Parliament. The subject has been thus thoroughly thrashed out, and the large and important areas assigned to this company will be supplied with the electric light under satisfactory conditions, which have, moreover, the advantage of both Departmental and Parliamentary sanction.

The company is seeking powers to supply other areas of the Metropolis, and has given the requisite notices to that effect.

It must be understood that the position of the company with regard to its allotted areas has been only recently sufficiently assured to warrant the directors in completing their system of supply. It was not until after the Royal Assent had been given to the Confirmatory Acts in August last that the company was authorised to break up streets for the purpose of laying underground mains. Notwithstanding this, it will be seen by the following list of central stations that good work has been done, and that the demands on the recently completed station at Sardinia Street are already so great as to necessitate a duplication of the existing plant.

CENTRAL STATIONS.—For supplying electricity in the company's areas the following stations have been erected, are in course of erection, or are about to be erected:—

(1.) Erected and Working.—(*a*) *Whitehall Station* (Continuous Current).—This station is now about to be fully employed, the demands for current being in excess of its capacity, regard being had to the requirements of Whitehall Court when completed.

(*b*) *Sardinia Street, Lincoln's Inn Fields* (Alternate Current Transformer).—This station commenced working on September 21st last. The demand for light being in excess of the present capacity, the directors have lately decided to order the completion of the station, by which its power of supply will be more than doubled.

(*c*) *Rathbone Place, Oxford Street* (Alternate Current Transformer).—A small station on this site was purchased in February last as a going concern. Arrangements were made for the erection of a larger plant, and a portion of the new machinery is now running. The full capacity of this station is also fully engaged.

(2.) In Course of Construction:—(*d*) *South Mews, Manchester Square, Marylebone* (Alternate Current Transformer).—A large station is in course of construction on this site, and will, it is expected, commence working next spring.

(*e*) *Waterloo Wharf* (Alternate Current Transformer).—The machinery for this station is in a forward state, but the directors have delayed erecting buildings owing to negotiations, which are not yet concluded, with the London County Council.

(3.) About to be Constructed:—(*f*) A station within the Strand District (now being partially supplied from Sardinia Street).

And conditionally on the company obtaining the powers for which they are seeking:—(*g*) A station to supply the western portion of the City; and (*h*) A station to supply Paddington.

The auditors, Messrs. Deloitte, Dever, Griffiths & Co., retire, and offer themselves for re-election.

Balance sheet, September 30th, 1889.—To share capital:—49,900 ordinary shares of £10 each, £499,000, 100 founders' shares of £10 each, £1,000—£500,000; to shares issued:—43,900 ordinary shares of £10 each on which has been called £3 per share, 2,032 ordinary shares of £10 each issued as fully paid, 100 founders' shares of £10 each fully paid, together £149,234 9s.; to loan from bankers, £10,043 11s. 3d.; to sundry credit balances, £42,305 1s. 11d.; total, £201,583 2s. 2d. By capital expenditure:—Expenditure on stations at Whitehall, Sardinia Street, Rathbone Place, Manchester Square, Marylebone, Waterloo and Greenmore Wharves, battery rooms, offices, overhead and underground mains, &c., £143,996 10s. 4d.; Eccleston Place property, £12,520 7s. 6d.; consulting engineer's fees, legal expenses, accountant's charges, maps, plans, &c., £1,623; Parliamentary expenses and Board of Trade enquiry, £4,803 16s. 2d.; preliminary expenses, £5,052 10s. 4d.; installation and general expenditure:—Engineering department (£2,907 16s. 9d.), working and maintaining the stations, rents, rates, taxes, management, directors' fees, and other expenses (£13,053 6s. 8d.), less supply of light and power, and other income (£6,127 5s. 2d.)—£9,833 18s. 3d.; by office furniture, £673 14s. 5d.; by stocks of tools, stores, materials, &c., per valuations, £3,601 1s. 10d.; by sundry debtors, £9,522 18s. 3d.; by cash at banks and in hand, £9,955 5s. 1d.; total, £201,583 2s. 2d.

The Gülcher (New) Electric Light and Power Company.—The second ordinary general meeting of this company was held on Wednesday last at Winchester House, Old Broad Street, Mr. De Castro presiding. By a misapprehension our reporter was allowed to take notes of the proceedings, but we were informed afterwards that the meeting was intended to be a private one, and we were requested to submit our report to the Managing Director lest matters should be published which, in the interest of the shareholders, it was considered desirable to keep from the public. We have always a decided objection to submitting transcripts of our shorthand "notes" to anyone not connected with our staff, and decided, therefore, that the best interests of the company, and probably of the public, would be served by our omitting any report, garbled or otherwise, of the said meeting, and by explaining thus our position in the matter.

The Eastern Extension (Australasia and China) Telegraph Company, Limited, notify that the coupon on their 5 per cent. Australasian Government subsidy debentures, due on January 1st next, will be paid on and after that date at Messrs. Barclay, Bevan and Co.'s, 54, Lombard Street, E.C. Coupons must be left three clear days for examination.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The traffic receipts for the week ending December 13th, 1889, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £4,017.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 15th December are £2,803, as compared with £2,836 in the corresponding period of 1888.

THE PORTSMOUTH CORPORATION AND ELECTRIC LIGHTING.

THE question of electric lighting, which has now been under discussion at Portsmouth for some years, has (says our correspondent) at length been partially settled by the determination of the

Corporation, formally ratified at a meeting this week, to undertake themselves to supply the town with the modern illuminant. Applications for provisional orders have already been lodged with the Board of Trade by the Portsmouth and South Hants Electric Supply Company and by the Laing, Wharton, and Down Construction Syndicate, Limited, and the Town Council, on being asked by both companies for their support, immediately took alarm, lest another monopoly similar to that at present enjoyed by the gas company should be established in the town. Mr. Douglas M. Ford, as secretary of the Portsmouth and South Hants Electricity Supply Company, wrote to the Town Clerk, informing him that, although the Electric Lighting Acts give the power of purchase at the end of forty-two years, the directors were quite willing in the interests of the ratepayers to give to the Corporation the right of purchase at an earlier date, subject to the approval of the Board of Trade, and they suggested that the Corporation should have the option of acquiring the Company's undertaking at the end of twenty-one years on arbitration terms. The endeavour to effect a compromise, however, failed and the opinion of the Council being strongly averse to private companies being allowed to gain an independent footing, it was resolved to affix the common seal of the Council to a memorial to the Board of Trade for a provisional order, permitting them to light a portion of the borough by electricity. It was also decided to oppose the applications of the private companies for provisional orders.

THE COLUMN PRINTING TELEGRAPH MACHINE.

THE Comptroller of Patents had before him on the 16th inst., at the Law Courts, the opposition of the Exchange Telegraph Company to the Column Printing Telegraph instrument, patented by Messrs. Wright and Moore, and owned by the Column Printing Telegraph Syndicate (Limited), which has an arrangement with the well-known Central News Agency for supplying news to newspapers, clubs, exchanges, news rooms, &c. This machine is intended to supersede the present "tape" system of delivery of news, by giving it in the form of a printed page.—Mr. Moulton, Q.C., who had with him Mr. Isaacs, instructed by Messrs. Rollit and Sons, appeared for the Column Printing Syndicate.

Mr. MOULTON said he appeared for the applicants, Messrs. Wright and Moore, who apply for the seal to their patent, No. 10,437 of 1888. They were opposed by a Mr. Higgins, whose statutory declaration had been answered by Mr. Moore, and no evidence had been filed in reply. Mr. Graham, who was for the Exchange Telegraph Company, said that declaration had been filed. Mr. Moulton replied that he had not heard of any, but in any case he did not think it mattered, as the ground of the opposition was that the inventions for which patent is sought had been patented in patents of prior date. He proceeded to say that the opposition was radically bad on all grounds. It was one of those opposition cases which are based on a fundamental misconception of the issue to be tried. If a person could swear that a machine would be an infringement of a previous patent, that was no objection to the granting of a new patent. The best way to show the baselessness of the opposition was to take their own declaration and go through their objections one by one.

This the learned counsel did *seriatim*, setting forth the technical points with great clearness and precision, arguing that every one of the objections put forward by Mr. Higgins were absolutely untenable.

Mr. GRAHAM, in reply, abandoned all the objections put forward by the Exchange Telegraph Company with the exception of their opposition to the first clause, wherein the patentees show that the return of the type-wheel at the end of the line is brought about by the use of a stronger current, which, curiously enough, Mr. Graham said, might be read as "a longer current." Finally, Mr. Graham agreed to withdraw all opposition, if Mr. Moulton would consent to the clause being worded as follows:—"A printing telegraph for printing in line, in which the commencement of a new line is effectuated by an electro-magnet energised by the reception of a stronger current than that used for printing, so as to actuate an escapement mechanism."

Mr. MOULTON pointed out to the Comptroller that this was only the same thing, put in a slightly different form, and the Comptroller would accordingly affix the seal to the patent of Messrs. Moore and Wright. Of course this does not prevent the Exchange Telegraph Company taking an action for infringement if so advised; but, considering the result of the action before the Comptroller, and the fact that the Column Printing Syndicate has had its instruments working now for some months in newspaper offices, and that the officials of the Exchange Telegraph Company have very closely inspected them and their working, any such proceeding does not, on the face of it, promise much hope of success. Possibly the Exchange Telegraph Company has recognised this, for on no other ground can its apathy be explained or understood, considering that the company has been advertising regularly that it will prosecute anyone selling or using column printing machines which are infringements of its patents. The inference is, that as there has been no prosecution, according to the advertisement, there can have been no infringement.

FORM AND EFFICIENCY OF INCANDESCENT FILAMENTS.*

By CHARLES J. REED.

IF we pass an electric current through any conductor, as a cylindrical wire, its temperature tends to increase by the transformation of electrical energy into heat. If no heat is allowed to escape, the temperature will increase indefinitely, or until the conductor is melted or otherwise destroyed. If the heat is allowed to escape by radiation alone from the surface of the conductor, its temperature will increase only until the rate of loss by radiation is exactly equal to the rate of transformation. By heat we here include all radiant energy, whether of high or low degree.

As the temperature of an incandescent body increases, not only does the actual quantity of radiant energy increase, but its wave lengths diminish. Hence, as experience has shown, after incandescence is reached, increasing the temperature in a given ratio increases the light emitted in a much greater ratio.

The exact relation between temperature and luminosity is not known, and it is probably not very simple, if such a relation exists at all. The phenomenon of luminosity is really a physiological one, and depends partly upon individual optical capacity; some persons being able to see above and some below the visible spectrum of the average human eye. The radiant energy we call light is one thing. The sensation of luminosity by which we always estimate light is an entirely different thing. A constant source of light may vary greatly in luminosity, according to the condition of the respective mechanism and its individuality.

But even ignoring the physiological aspect of the question, the nearest approach we have to formulæ for radiation are the approximate empirical formulæ of Dulong and Petit, and of Stefan, which are for total radiations of a low temperature and limited range. They cannot apply to light alone, nor even to total radiation of high degree.

It is unfortunate that there exists no instrument more reliable than the retina of the living eye for measuring the intensity of radiant luminiferous energy, and no method of reading the measurements more accurately than individual guesses. We can measure radiant thermal energy of low degree with Langley's bolometer; we can measure radiant actinic energy by the chemical action it produces, and we can measure total radiant energy in a variety of ways; but how can we isolate or measure radiant luminiferous energy? If there were a high temperature thermometer or other instrument for accurately measuring high temperature, we might attack this problem with some hope of results.

It is sufficient, however, for our present purpose to know what the eye is able to tell us, namely, that increasing the temperature increases the light in a greater ratio. From this it follows that the efficiency of an incandescent filament is some direct function of its temperature above that of the surrounding space.

Granting that the efficiency increases with increased temperature, we have now to determine whether the efficiency does or does not depend on any other conditions. It has frequently been claimed that the efficiency depends upon the form of the filament, whether it be cylindrical, flat, or square. At a meeting of this institute of June 8th, 1886, for instance, this was by general consent considered an established fact.† Others have asserted, but without giving any proof, that the efficiency depends upon the pressure, some claiming that low tension series lamps, and others that high tension multiple lamps are the more efficient. Others, again, have claimed that at the same pressure, and with the same shaped filament, lamps of greater candle-power have a different efficiency from lamps of smaller power.

The trouble seems to have been that we are not

* Read before the American Institute of Electrical Engineers New York, November 10th, 1889.

† Transactions Am. Inst. E.E., Vol IV., p. 20—22

always careful to distinguish between efficiency and convenience, or adaptability. Each individual finds that a certain form of filament, or a certain method of distributing, gives better satisfaction than another, or is more suited to his purpose, and soon persuades himself that it is "more efficient" than any other.

In order to study the effects of these various conditions upon the efficiency of a filament, it will be convenient to eliminate the effects which we know will be produced by variations in temperature. We assume, therefore, in this discussion, that all the filaments, and all parts of the filaments under consideration are at the same temperature.

Let T represent this temperature, and T^1, the temperature of the supposed vacuous space surrounding the filament. We must assume further that the material of which the filaments are constructed is perfectly homogeneous in itself, and that it is uniform in all the various forms of filaments considered.

Let S denote the specific radiating power of the material at the temperature, T, and S', its specific resistance at the same temperature.

Any variation in S or S^1 might affect the efficiency, and for this very reason experimental proof is very difficult to obtain. Comparisons of filaments made by different processes are entirely worthless in determining the effect of form or length of a filament on its efficiency.

It is a difficult matter to produce by the same process two carbons of different sizes and shapes that shall have the same specific radiating power and specific resistance at the same temperature. And to produce them by different processes is entirely out of the question. Any comparison, therefore, of short series filaments with long multiple filaments of a different manufacture is of no value whatever in settling this question.

Let C represent the candle-power of any filament at temperature, T.
c, its current.
E, the potential difference at its terminals.
R, its resistance.
r, its radius (considered as a cylinder).
L, its length.
H, the energy received per unit of time.
H', the energy radiated per unit of time.

Since the energy developed in any portion of an electric circuit is proportional to the current and pressure, we have

$$H = K E c, \qquad (1)$$

in which K is a constant depending upon the units employed.

If we neglect the small quantity of heat lost by conduction from the ends of the filament to the conducting wires, and assume that the space surrounding the filament is a perfect vacuum, then the entire energy of the current will be expended in radiation, and we have

$$H = H'. \qquad (2)$$

Let K^1 represent a constant depending on $T - T'$.

The rate of radiation of any surface depends only upon the elevation of its temperature above that of the surrounding space and the specific radiating power of the surface at that temperature. We have, therefore—

$$H = H' = K' S \times 2 \pi r L = K E c. \qquad (3)$$

The resistance of any conductor is proportional to its length and inversely proportional to its cross-section, and we have—

$$R = S' \frac{L}{\pi r^2} \qquad (4)$$

From Ohm's law and (4)

$$c = \frac{E}{R} = \frac{E \pi r^2}{S^1 L'} \qquad (5)$$

By eliminating successively E, c and r from (3) and (5) we get:

$$\frac{K' S \times 2 \pi r L}{K E} = \frac{c S' L}{\pi r^2}, \text{ or } \frac{c^2}{r^3} = \frac{2 \pi^2 K' S}{K S'} \qquad (6)$$

$$\frac{K' S \times 2 \pi r L}{K E} = \frac{E \pi r^2}{S' L}, \text{ or } E^2 r = \frac{2 K' S L^2 S}{K} \qquad (7)$$

and

$$\frac{K E c}{K' S \times 2 \pi L} = \sqrt{\frac{c S' L}{\pi E}} \qquad (8)$$

From (6)

$$K' S \times 2 \pi^2 r^3 = K S' c^2.$$

Hence

$$r = \sqrt[3]{\frac{K S' c^2}{2 K' S \pi^2}} \qquad (9)$$

and

$$c = \pi \sqrt{\frac{2 K' S r^3}{K S'}} \qquad (10)$$

showing that the square of the current is proportional to the cube of the radius or diameter of the filament for all lamps at constant temperature; and that this relation is independent of the pressure, of the length and resistance of the filament, and independent of the candle-power.

From (7)

$$K' S \times 2 L^2 S' = K E^2 r.$$

Hence

$$L = \sqrt{\frac{K E^2 r}{2 K' S S'}}, E = \sqrt{r} \sqrt{\frac{K}{2 K' S S'}} \qquad (11)$$

and

$$r = \frac{L^2}{E^2}, \times \frac{2 K' S S'}{K} \qquad (12)$$

showing that the ratio of the square of the length to the diameter depends only upon the pressure and is independent of candle-power and resistance.

From (8)

$$K^2 E^3 c = 4 \pi K^2 S^2 S' L^3.$$

Hence,

$$E = \frac{L}{\sqrt[3]{c}} \sqrt[3]{\frac{4 \pi K'^2 S^2 S'}{K^2}} \qquad (13)$$

and

$$c = \left(\frac{L}{E}\right)^3 \times \frac{4 \pi K'^2 S^2 S'}{K^2} \qquad (14)$$

showing that the current is proportional to the cube of the ratio of the length to the pressure.

Since K', S and S' are constant, both the light and the heat radiated will be proportional to the surface, and we have

$$C = K'' L \times 2 \pi r \qquad (15)$$

in which K'' is a constant depending upon the units employed and upon T,

Hence,

$$L = \frac{C}{2 \pi K'' r} \qquad (16)$$

and

$$r = \frac{C}{2 \pi K'' L} \qquad (17)$$

EFFICIENCY CONSTANT.

Combining (15) with (3)

$$\frac{K' S C}{K''} = K E c,$$

or

$$\frac{C}{K E c} = \frac{K''}{K' S} \qquad (18)$$

which shows that the candle-power is proportional to the energy, $K E c$; or that the efficiency, $\frac{C}{K E c}$, is constant and independent of the pressure, length, radius and resistance, current and candle-power of the filament. This means that the energy required to produce a given candle-power will be proportional to the candle-power, and will be the same, whether it is expended in driving a large current through a short, thick filament, or a small current through a long, slender filament; provided the temperature or state of incandescence is the same, and provided no heat is lost by conduction through the terminal wires.

Equation (18) shows also that the efficiency does depend upon K' K'' and S, that is upon the temperature of the filament, the temperature of the surrounding space and the specific radiating power, and upon them only.

From (18)

$$C = E c \times \frac{K K''}{K' S} \qquad (19)$$

$$E = \frac{C}{c} \times \frac{K' S}{K K''} \qquad (20)$$

and

$$c = \frac{C}{E} \times \frac{K' S}{K K''} \qquad (21)$$

From (4)

$$r = \sqrt{\frac{S' L}{\pi R}} = \sqrt{\frac{S'}{\pi}} \times \sqrt{\frac{L}{R}} \qquad (22)$$

and

$$L = \frac{\pi r^2 R}{S'} \qquad (23)$$

From (5)

$$E = R c \qquad (24)$$

From (21) and (24)

$$\sqrt{c} = \frac{C}{c R} \times \frac{K' S}{K'' K} = \sqrt{\frac{C}{R}} \times \sqrt{\frac{K' S}{K'' K}} \qquad (25)$$

FORM OF CROSS SECTION.

We have thus far confined ourselves to the consideration of cylindrical filaments varying in length and diameter. It remains now to show that the efficiency is independent of the form of cross section.

Let us suppose we have a number of lamps, all made of the same material, having the same specific resistance and radiating power, all burning at the same temperature, and all giving the same amount of light. Let them be of any pressure and let the cross section be of any form, circular, elliptical, square, triangular, &c. The filaments will all have equal radiating surfaces; since unequal surfaces of the same character at the same temperature could not radiate equal amounts of light. But equal surfaces of the same character at the same temperature must radiate equal amounts of heat of all wave lengths. Hence the total amounts of radiant energy are equal. Since the energy received is equal to the energy radiated, and the amounts of light are equal, we have

$$C = Q E c \qquad (26)$$

in which Q is a constant; and from (18) we find its value to be

$$Q = \frac{K' K''}{K S} \qquad (27)$$

This shows that the efficiency is independent of the form of cross section of the filament and depends only upon the temperature, the specific radiating power of its surface and the temperature of the surrounding space.

When we find, therefore, that one lamp is more efficient than another we must infer, not that it is so on account of larger or smaller size, not because it is on a series or on a multiple circuit, not that it is so because it has high or low resistance, or a certain form of cross section, but that it is at a higher temperature, or is made of material having a different specific radiating power.

(*To be concluded.*)

ELECTRIC LIGHTING AND THE COUNTY COUNCIL.

LAST Tuesday, at the meeting of the London County Council, Mr. Westacott (the Chairman of the Highways Committee) presented a report stating that a letter had been received from the Kensington and Knightsbridge Electric Lighting Company, stating that some of the boxes approved by the Council had proved to be too small; asking that, as a temporary measure and to prevent delay in supplying electricity from the mains already laid, the company might be allowed to use other boxes which it had in stock; and undertaking to replace such boxes with some of a size and pattern to be hereafter approved, should the Council so require. It was no doubt a matter of considerable importance to the Company to be able to make use of its mains, and for this the use of some boxes was essential. The Committee, having given careful consideration to the application, and to a report upon it by Mr. Gunyon, of the Engineer's department, recommended that the company be allowed to use such of the boxes referred to as were of the same general description as those which had been approved by the Council, upon condition that the company gave an undertaking to remove within six months any of such boxes to which the Council might object, and to substitute for them others of a size and pattern to be hereafter approved by the Council.

The recommendation was approved without discussion.

Applications from the same company were reported for permission to carry out works in Cornwall Gardens, Elvaston Place, Gloucester Road, Greville Place, Exhibition Road, and Chapel Place, and sanction was granted subject to certain conditions.

With respect to an application from Messrs. L. Clark, Muirhead & Co., on behalf of the St. James's Company, the Highways Committee, after having received reports from the solicitor and the engineer, recommended, and the Council resolved: "That the sanction of the Council be given to the laying by the St. James and Pall Mall Electric Lighting Company of mains in the Shaftesbury Avenue subway and through Piccadilly Circus to Tichborne Street, subject to the condition that the work shall be carried out, and that any damage which may be done to the subway shall be made good, under the supervision and to the satisfaction in all respects of the proper officers of the Council, and at the sole cost of the company; and further, that the company, before commencing the work, do give an undertaking, to be prepared by the solicitor, to pay such an annual amount for rent for the use of the subway as may be settled by agreement, or, in case of difference, by arbitration."

PROCEEDINGS OF SOCIETIES.

The Institution of Electrical Engineers.

(*Concluded from page* 680.)

ISOLATED PLANTS.

Let us now turn for a few moments from central stations to what are called "private installations" in this country and "isolated plants" in America. I have already spoken of internal construction work, or wiring and fittings, in connection with central stations. With isolated plants there is not much difference. Of course, the character of the work differs greatly in different places, as it does here; but, taking it as a whole, I don't think it is equal to our standard, whether from an engineering or artistic point of view. I noticed, by the way, that there is a much greater tendency to turn incandescent lamps upwards in fittings, like gas jets, instead of downwards, as with us the majority of lamps are turned. Isolated plants are driven by steam and gas engines, located in cellars and basements, exactly like they are here. As you are aware, accumulators are not so generally used; I only saw the set at the New York Electric Club. With respect to dynamos, the Americans have been fully alive to the developments, both theoretical and practical, in our knowledge of the magnetic circuit which have taken place during the last four or five years, and all their modern machines appeared to me fairly up to date in this particular. What I may be permitted to call the Edison-Hopkinson type, the Kapp type, the Manchester type, and the Weston type—the latter with two magnets, placed horizontally—appear to be the favourites, just as they are here. The construction and workmanship of the machines appeared to be much on a par with our own; there is little to choose between in one or the other. As to the way the installations are run, judging by that crucial practical test, the look of the commutator and brushes, it is much the same as here; certainly, I think, on the whole, not better. The lamps, as a rule, I did not find any steadier, nor are they kept nearer their proper voltage than they are here. This applies to arc lamps as well as incandescent: there is no magic about arc lamps over on the other side of the water; they are subject to the same vicissitudes and uncertainties as they are here, and do not burn steadier than those in any moderate sized station here, where the appliances are such that the lamps get a fair chance.

The switchboards in these private installations are nearly always mounted on wood, and there is even a disposition to cut things fine in the strength and solidity of these wooden baseboards, somewhat, as it seemed to me in one or two instances, at the expense of efficiency and lasting qualities.

ELECTRICAL TRAMWAYS.

Such very full accounts have been published of everything that has been done in this direction, that there is really little I can add to them. In the *Electrical World* for October 19th there is published a table of the electrical tramways in actual operation, *and under contract*, in the United States. The total mileage of both is 1,260 miles, with 1,884 cars, on 179 roads. Of this, 716 miles were, it appears, actually being operated by electricity at the date of the return, and 544 miles were under contract. Of this total, 21 miles were worked by cars with storage batteries, and all the rest, with the exception of two or three miles, by overhead conductors.

Nothing can be simpler than the way these overhead conductors are put up. Two lines of posts, about 20 feet high, are set up opposite each other, one on each side of the street; light steel wires are run across from one to the other; a small iron holding-piece is attached to the centre of the steel suspender, and this

holding-piece carries a bare hard-drawn copper wire, along which the current flows, returning by the rails. Where feeders are used, they run along one side of the street, and connections are made at intervals with the central wire. The way the conductor is carried round corners is on a par with the rest of the work. Posts are set at the further corners of the street, and from each of these two, three, or four steel wires are run at an angle with each other, meeting corresponding wires run from posts on the inner side of the curve. In this way the wire is made to take the form of part of a rough polygon, while the horizontal and vertical movements of the fishing-rod connector on the car are sufficiently ample to keep the contact-wheel on the wire when the car is going round a corner.

This method of erection does not look very nice, certainly, but it appears to answer the purpose well. Such work could, I think, be more solidly carried out here for about £70 a mile. In a few places standards with projecting arms placed in the centre of the street have been used for carrying the overhead conductor. If neatly constructed, there is no reason why these should be unsightly, and they can be used for the further purpose of lighting the streets.

A great point about these electrical tramcars is the way in which their speed can be varied. They can be run at three or four miles an hour in crowded streets and while turning corners; or in broad roads in suburbs, where there is not much carriage traffic, the pace can be increased to 16 miles an hour. The cars are stopped very quickly and reversed, and will, of course, run either way on the same track.

The companies claim a reduction of 50 per cent. in the cost of working over the employment of horses, putting aside all the extra facilities which the electrically propelled car gives. A very noticeable point about all electrically propelled cars is the quiet and gradual manner in which they start and come to rest, and the evenness of their motion while running. In these points they greatly surpass both cables and horses. I took the opportunity of talking with a good many members of the general public in the train and hotels about the working of these cars. There is no doubt that the outside public thoroughly appreciate them and understand their value. At present electrical tramway work is the most "live" branch of the electrical industry in the States, and everyone connected with it was full of buoyancy and hope at its future prospects. It is really sad to think that, after all the skill and care which has been lavished on electrical tramway work here, it should be dragging along in such a half-hearted and pottering fashion.

While in America, through the kindness of Mr. Lockwood, I had an opportunity of going over the telephone exchange system of New York with him, and of seeing the Courtland Street Exchange, which contains more than 3,500 subscribers, and is capable of extension to double that number. I also visited the Western Electric Company's factories, both in Chicago and New York, where all the telephonic apparatus for use in the States is made. Although a description of the present state of this industry would properly come under the heading of my paper, seeing that the paper has already extended to such length, and that, owing to circumstances, telephony is a matter of comparatively limited interest here, however important in itself, I will not say more about it, but will conclude with a few general remarks.

Conclusion.

In the early portion of this paper I endeavoured to convey an idea of the roughness and crudeness of American outside construction work. After reading over the proofs of the paper, I do not think I have overdrawn the picture; rather it is underdrawn, if anything. At the same time, I do not wish it in any way to be understood that American engineers are necessarily rough and untidy in their ideas and incapable of different work. Besides their electrical plant, the numbers of beautiful tools, crowned by the latest pattern of the phonograph, which come over here from America, point to an entirely different conclusion. In accuracy of workmanship and careful finish, when they consider it suits their purpose, the Americans are our equals, if not our superiors: the difference lies in the fact that our ideas often differ from theirs as to where this accuracy and careful finish should come in. English engineering would hardly dare to appear before its fellow-citizens as the responsible owner and designer of such a terrible eyesore as American outside work is; but the American engineer appears to look at it from a different point of view. It is not his business to think of his fellow-citizens. Each of his fellow-citizens, he considers, is quite competent and capable of taking care of himself. It is the business of the electrical engineer to forward and extend the applications of electricity. If in doing this he does anything disagreeable to his fellow-citizens, it is for them to protest when it becomes intolerable to them, not for him to think of it beforehand.

And I would like you to try and think for yourselves, and really feel the enormous facilities which American engineers have in the past enjoyed, and still enjoy, in extending their business, by simply being allowed to erect open wires everywhere through the streets. Even where wires are now being put underground, they are largely put underground in order to carry on existing work and to extend it, not merely to take advantage later of what may chance to turn up on the route.

Besides this, we have all had it drilled into us by this time that it does not matter how perfect, how desirable, how useful a thing is likely to be, before it can come into general use the public have got to be educated up to it, to see it, and feel its desirability and utility, and its practicability—to understand it each man for himself. Now, the American system of overhead wires and cheap line construction, bad as it may be in itself, has from the very first brought electricity home to everybody—right to their very doors—not so much as a luxury, but as a practical desirable factor of everyday life, an attraction to public resorts, and a good advertisement for business. Consequently electricity is in America no more a wonder, but a fact of everyday life to an extent that it is not yet here.

Looking at their plant, looking at their apparatus, and looking at the facilities which Americans have enjoyed for extended practical experiments on a large scale, it does not appear to me that their actual achievements, simply from an engineering and scientific point of view, have been greater than ours have, in spite of the apathy on the part of the public and investors with which we have had to contend. Still, the fact remains that they have done more business than we have, even considering the difference in population.

Of what work we have done so far, Englishmen may feel justly proud, and with better times I trust we may still be able in friendly rivalry to show that we are competitors worthy of America's best mettle.

Authorised Abstract of Discussion.

The President, in inviting discussion, remarked that a paper of such interest could not be adequately dealt with in the time then at their disposal, and announced that the discussion would be continued at the next meeting on December 12th. In the meantime printed copies of the paper can be had on application to the secretary.

Prof. Forbes admired the realistic description of electrical work in the United States given in the paper, and fully endorsed the author's account of American electrical engineering, particularly as regards the rough-and-ready way in which the work is usually carried out. Although this class of work may be necessary for the rapid extension of electric lighting (as well as of railways) in America, where great distances have to be covered, yet he thought the more solid construction adopted by English engineers would prove better in the long run. For some time past he had frequently heard of great advances made on the other side of the Atlantic, and expected to have heard something definite about them from Mr. Addenbrooke, but, with the exception of electric tramways, little change seems to have been made since his visit two years ago. At that time, however, most tramways were worked by accumulators. Information about motors and meters would have been very acceptable, particularly for alternating current work. Speaking of American factories, Prof. Forbes said that great attention was paid to testing, and as a result the efficiency of converters had been considerably increased. As regards distribution, he was glad to hear of the frequent use of feeders, and hoped they would be more generally adopted in England. In conclusion, he asked what kind of cable was used for underground work.

Mr. H. C. Donovan considered that the apparent disregard of insulation was to be attributed to the dryness of the climate, and expected to have seen this brought out in the paper.

Mr. W. P. Granville said the usual method of specifying insulation resistance of cables (viz., in megohms per mile) was unsatisfactory, and that the diameter of the conductor should be taken into account, for if this is not done the same material used on conductors of different sizes would give quite different insulation resistances. He also thought that the insulation tests of lead-covered cable should be made before sheathing, and whilst the cable is immersed in water. In his opinion the whole subject required reconsideration.

Prof. S. P. Thompson had hoped to hear that in the five years since he visited the States improved methods of wiring, &c., would have been adopted, but no great change seemed to have taken place, excepting in the use of alternating currents. On his visit he obtained an insulator even more crude than the one described by Mr. Addenbrooke. This he promised to exhibit at the next meeting. After making enquiries as to the kind of motor used in the constant current arc circuits, Dr. Thompson expressed his opinion that the alleged greater steadiness of American arc lights was not due to any superiority in the design or workmanship of the lamps, but to the greater personal pride and confidence which the attendants have in the particular system with which they are connected.

Mr. Swinburne pointed out the great difference which exists in the management of English and American factories, and thought the system adopted in the latter, where the perfecting of designs and the experimental work are kept quite distinct from the wholesale manufacturing part of the business, was most likely to lead to success. So far, however, he believed machines of English design better than American, for the weight efficiency of the former is generally higher. Referring to Mr. Granville's contention, he said that instead of insulation resistances being given in megohms per mile, they should be expressed in megohm miles for each size of conductor.

The President, whilst deprecating imperfect work in general, thought it advisable that English electricians should acquire whatever good could be got from the "rough and ready" method adopted in America, and considered that progress might be retarded by waiting too long to attain perfection. He was anxious to know how constant currents were used for motors, and also whether the overhead wires used for tramways interfered with the ordinary street traffic.

Replying to Prof. Forbes's question as to recent advances, Mr.

ADDENBROOKE said he had not concerned himself with them, for his object was to see the systems and apparatus in common use. As to motors, he made no enquiries respecting their peculiarities, but as regards meters he was informed that numbers of the Westinghouse type were in constant use. He agreed with Prof. Forbes about the way in which testing is appreciated, and with Prof. Thompson as regards the interest which the men take in their work; the latter fact Mr. Addenbrooke attributed to better wages and greater chances of promotion. Speaking of the insulation of cables, he thought the absolute thickness of insulating material should be stated. In reply to the president's question relating to tramway wires, Mr. Addenbrooke pointed out that they were placed 8 or 9 feet above the tops of the cars, contact being made by a "fishing-rod" connection. In some cases these wires are carried by brackets projecting from poles fixed along the middle of the roadway, the poles being also utilised for supporting arc lamps and for general lighting circuits.

December 12th, 1889.

After the adoption of the report of the Council, and the passing of the usual votes of thanks, the discussion on Mr. Addenbrooke's paper, "Electrical Engineering in America," was renewed.

Mr. LANT CARPENTER, who paid a hurried visit to America during August and September, said he quite concurred in Mr. Addenbrooke's remarks about the temporary character of the work, particularly in the Western towns. In many places on the Pacific slope, he found that water-power was extensively used, both for arc lighting and for tramway work; one town in Washington, he observed, had laid down electric tramways before making the common roads. Incandescent lamps are comparatively rarely seen in the far West, and from enquiries he learned that where they had been tried, the stations were so badly managed that the life of the lamps averaged between 200 or 300 hours. Passing on to Canada, he said that Quebec, Montreal, and Ottawa were all lighted electrically by water-power, and, in the latter city, he was informed that many alternate current motors of the Tesla type were in constant use. Another fact that struck him was the large numbers of long-distance telephone wires in use in the States. He also noticed that many of the wires were now being put underground.

Mr. G. S. RAM said he could not agree with Mr. Addenbrooke on the glaring character of arc lamps fixed on poles, and added that the tower system had been almost abandoned in New York in favour of poles. He greatly preferred the blaze of light in that city to the comparative darkness of London. As regards the character of overhead work, he thought the account given in the paper was not overdrawn, and, in support of this, he exhibited a photograph of a building in Broadway, New York, in which hundreds of wires were unintentionally included. On careful examination of the photograph, the insulation on some of the wires was seen to be hanging in shreds.

Mr. SPAGNOLETTI thought the necessities for insulation were so different in England and America, that the systems could not be compared on the same basis. To show the great variation of insulation resistances in this country, he said that on the South Wales Branch of the Great Western Railway, the insulation resistance of the telegraph lines varies from several megohms to a few thousand ohms, according to the weather. He also mentioned the difficulties experienced by Mr. Edison when experimenting in London and at Ealing with his automatic chemical telegraph; the maximum rate he could attain here was 500 words per minute, whereas in America he could get 2,000.

Mr. PREECE, speaking of insulation requirements in the two countries, said that, in his opinion, the differences arose from the facts that the prevailing winds here are warmed and moistened by passing over the Gulf Stream, whilst in America the shores being washed by polar current, the winds are cold and dry. Referring to his own visits to America, the speaker said he always benefitted considerably by being associated with the "go-aheadedness" of American engineers, and he believed that on visiting this country American engineers derived similar advantages.

Mr. CROMPTON said the paper would bear a good deal of study, and there were some points upon which he desired further information. For example, the method of preventing vibration mentioned on slip 6 of the paper, would, if effective, be of great importance, for one would have expected such an arrangement to increase rather than diminish vibration. Judging from the remarks about regulating resistances, he would infer that in this respect America was behind European practice, for on this side of the water such resistances had been done away with. The fact of alternate current machines not being usually run in parallel (as attested by Mr. Addenbroke) tended to confirm his (Mr. Crompton's) statements made in his paper on "Central Station Lighting," read in April, 1888. As regards the boiler described on slip 10, he thought such a design would not be tolerated in this country, for the upper parts of the tubes were liable to get overheated and collapse. Speaking of tramway work, Mr. Crompton said American engineers had been greatly favoured by being allowed to erect overhead wires anywhere and anyhow, but he was afraid such facilities would never be granted in England.

Mr. A. RECKENZAUN deprecated the wholesale condemnation of posts made by Mr. Addenbroke, and said that many were not unsightly, while some were ornamental. He considered the paper chiefly a criticism of the bad work done in America, and the good work was barely mentioned. For example, little is said of installations in which secondary batteries are employed, although there are many in constant operation; and electric railways are no described.

Mr. F. RECKENZAUN concurred in his brother's remarks about the unfair criticism contained in the paper, and thought the differences of opinion arose from the totally different ideas as to the way in which electrical engineering should be carried out. In the American methods, he said, great skill and ingenuity was shown in combining economy with simplicity and efficiency. Although the arc lamps are not ornamental, yet they are simple and efficient, and cheap construction admits of their being universally used. He agreed in general with Mr. Lant Carpenter's remarks on incandescent lighting, but was inclined to believe its limited use was due to the people wanting the biggest and best light obtainable at the price.

Mr. ADDENBROOKE, in reply to the Messrs. Reckenzaun, said he had specially mentioned in his paper that the Thomson-Houston Company were putting up work much better than the average, and as to posts, he was glad to say the tramway companies were making considerable improvements. The arrangement of flooring referred to by Mr. Crompton was not intended to diminish vibration, but to prevent such vibration being transmitted to the brickwork. As regards the boiler criticised by the same speaker, he (Mr. Addenbrooke) could only say that those in charge of them informed him that it was intended to have more of them. It was not his intention to criticise all American electrical engineering in a hostile spirit, for he thought there was little difference in the capacity of English and American engineers. The necessities, however, of the two countries were entirely different, and each had to adapt himself to his own surroundings. The motors used on the arc circuits were, as far as he could learn, simply series ones, provided with switches for cutting out parts of the magnet coils. In concluding, Mr. Addenbrooke said he had the opportunity of conversing with many of the American engineers who visited this country in the summer, and all were greatly pleased with the kind and courteous manner in which they were received.

After the thanks of the meeting had been given to the author for his paper, Dr. S. P. THOMPSON directed attention to some American blue glass insulators, which he had brought for inspection, and remarked that in a recent American work on electric lighting, which was now being circulated in this country, these insulators are recommended as suitable for almost any purpose.

Mr. ADDENBROOKE also exhibited a piece of the cable used in underground work in New York; the chief point of interest being the hardness of the insulating material employed.

Physical Society, December 6th, 1889.

Prof. REINOLD, President, in the chair.

Mr. J. W. Swan was elected a member of the Society.

The following communications were read: "On the Electrification of a Steam Jet," by SHELFORD BIDWELL, F.R.S. The author showed that the opacity of steam issuing from a nozzle is greatly increased by bringing electrified points near it, and that its colour is changed to orange-brown. Electrified balls and discs, when placed in the steam, produce similar effects, and when these are connected with an influence machine at work, the decolouration of the jet rapidly responds to each spark. On examining the absorption spectrum of the unelectrified jet, little or no selective absorption was detected; but on electrification the violet disappeared, the blue and green were diminished, and the orange and red remained unchanged. From these results the author concludes that electrification causes an increase in the size of the water particles in the steam, from something small compared with the wave length of light, to about $\frac{1}{5000}$th of an inch in diameter. Allied phenomena with water jets have been observed by Lord Rayleigh, who found that a straggling water jet is rendered much more coherent by bringing a rubbed stick of sealing-wax near it.

These observations are of considerable meteorological interest, for the steam jet phenomena go far towards explaining the cause of the intense darkness of thunderclouds, and of the lurid yellow light with which that darkness is frequently tempered.

After making his experiments, the author learnt that similar observation had recently been made by the late Robt. Helmholtz, who viewed the steam jets by reflected light against a dark background. On electrification, the jets became much better defined, and presented diffraction colours. Luminous flames also produced similar effects, and Mr. Bidwell has found that glowing touch-paper is equally efficient. Helmholtz conjectures that the sudden condensation may be due to molecular tremors or shock imparted by the electrification, upsetting the unstable equilibrium ot the supersaturated vapour, just as a supersaturated saline solution is suddenly crystallised when disturbed. Another hypothesis suggests that condensation is caused by the introduction of solid matter into the jet by the exciting cause, thus providing nuclei upon which the vapour may condense.

On reading Helholtz's paper the author tried the effect of gas flames on water jets, and found that when luminous they influenced the jet considerably, whereas non-luminous flames had no appreciable effect. He also found that luminous flames are positively electrified, and demonstrated this before the meeting.

Prof. Rücker thought the surface tension of the films surrounding the water jets would be modified by the presence of an electrified body, and that the smoke from the touch-paper used in some of the experiments on steam jets would introduce solid particles and facilitate condensation.

Mr. RICHARDSON enquired whether a red-hot iron had any effect.

Dr. FISON said he had made experiments on the electrification of flame, and found that potentials varying from + 2 volts to − 1½ volts could be obtained in the region within and surrounding a Bunsen flame.

Prof. S. P. THOMPSON commented on the contrast between Mr. Bidwell's experiments and those of Dr. Lodge on the dissipation of fogs by electricity, and also asked whether the colour of the jet depended on the length of spark produced by the machine.

Prof. FORBES thought a crucial test between the two hypotheses of Helmholtz could be obtained by trying the experiment in a germless globe.

The PRESIDENT said he had recently noticed that gas flames were electrified.

Mr. BIDWELL, in reply, said he ought to have mentioned that the effect of flames on jets may be due to dirt, for if soap or milk be added to the water in the steam generator, no effect is produced by electrification or flame. As to change of colour with spark length, little (if any) variation is caused thereby. He had not tried whether a red-hot iron produced any effect on a steam jet.

"On the Behaviour of Steel under Mechanical Stress." By Mr. C. H. CARUS-WILSON.

This is an enquiry into the properties of steel, as illustrated by the *stress-strain* curves given in automatic diagrams from testing machines, and by magnetic changes which take place during testing.

After pointing out that the permanent elongation of a bar under longitudinal stress consists of a sliding combined with an increase of volume, the author showed that the "yield" is caused by the limit of elastic resistance (ρ) parallel to one particular direction in the bar (generally at 45° to the axis), being less than along any other direction. When this lower limit is reached, sliding takes place in this direction until the hardening of the bar caused thereby, raises the limit of elastic resistance in the direction referred to, to that of the rest of the bar, after which the stress must be increased to produce further permanent set.

From considerations based on the stress-strain curves of the same material when hardened to different degrees by heating and immersion, &c., it was concluded that the increase of (ρ) during "yield" is the same for all the specimens, and that the "yield" is a measure of the "hardness."

The question of discontinuity of the curves about the "yield point" was next discussed, and evidence to the contrary given by specimens which show conclusively that the yield does not take place simultaneously at all parts of the bar, but travels along the bar as a strain wave. In these specimens the load had been removed before the wave had traversed the whole length; and the line between the strained and unstrained portions is easily recognised. As additional evidence of continuity, the close analogy between the *stress-strain* curves of steel of various degrees of hardness, and the isothermals of condensible gases at different temperatures when near their point of liquefaction, was pointed out; the apparent discontinuity in the latter probably being due to the change from gas to liquid taking place piece-meal throughout the substance (see Prof. J. Thomson, Proc. Roy. Socy. 71, No. 130).

In seeking for an explanation of the hardening of steel by permanent strain the author was led to believe this due to the displacement of the atoms within the molecules of the substance. To test this hypothesis experiments on magnetisation by stretching a bar in a magnetic field were made; these show that the magnetisation increases with the stress up to the "yield point," and is wholly permanent when approaching that point. On comparing his results with Joule's experiments on the elongation of loaded wires produced by magnetisation, the author infers that there are two kinds of elongation; firstly, that produced by relative motion of the molecules; and secondly, an elongation resulting from a straining of the molecules themselves. To this latter straining the hardening by permanent strain is attributed, and this view seems compatible with the results of Osmond's researches on the hardening of steel.

Mr. F. C. Hawe's paper was postponed.

NEW PATENTS—1889.

19304. "Improvements in electric motors and dynamo-electric machines." W. B. SAYERS. Dated December 2.

19335. "Improvements in voltaic batteries." J. C. MERRYWEATHER. Dated December 2.

19354. "Improvements in and relating to relays for telegraphic purposes." H. LUBLINER. Dated December 2.

19379. "Improvements in electric switches." B. M. DRAKE, J. M. GORHAM and E. ATKINS. Dated December 3.

19389. "Combined electrical steering and rudder indicating apparatus." W. H. WILLATT. Dated December 3.

19420. "Improvements in alternating current electro-magnetic motors." H. H. LAKE. (Communicated by N. Tesla, United States.) Dated December 3. (*Complete.*)

19426. "Improvements in the construction and mode of operating alternating current motors." H. H. LAKE. (Communicated by N. Tesla, United States.) Dated December 3. (*Complete.*)

19484. "Improvements in electrical switches specially applicable for electric vehicles fitted with two motors." F. V. ANDERSEN. Dated December 4. (*Complete.*)

19491. "Improvements in electric batteries." G. PHILIPPART. Dated December 4.

19497. "An improved electric meter." H. J. DOWSING and J. APPLETON. Dated December 4.

19554. "Improvements in the connections of alternating current generators and electric motors." M. VON DOLIVO-DOBROWOLSKY and the COMPANY ALLGEMEIN ELEKTRICITATS-GESELLSCHAFT. Dated December 5.

19555. "Improvements in electrical induction apparatuses or transformers." M. VON DOLIVO-DOBROWOLSKY and the COMPANY ALLGEMEIN ELEKTRICITATS-GESELLSCHAFT. Dated December 5.

19578. "Improved insulating material for electrical conductors. G. L. HILLE. Dated December 5.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1888.

16249. "An improved 'bar' or 'bridge' electric light switch." A. P. LUNDBERG. Dated November 9. 8d. Consists of an improved method of applying the throw-off springs, the springs being applied in such a manner as to cause the two ends of the contact bar or bridge to be pulled or pressed down on to the contact or pole pins, by the pressure of the two springs, each acting at equal distances from the centre of the bar or bridge, so as to remain equal pressure on both sides of the centre of the bridge, and thereby securing a good rubbing contact while the bridge is in motion, and a firm decided contact when the bar or bridge is in the "on" position. 1 claim.

17964. "Improvements in electric generators and motors." SIEMENS BROS. & Co. (Communicated from abroad by A. M. Taylor, of India.) Dated December 8. 6d. The inventor provides two iron rings preferably made up of iron wire or of laminated iron, each wound like a Pacinotti or Gramme ring, with an equal even number of coils of insulating conducting wire, such, for instance, as 16 coils. The one ring is so much smaller than the other that, with its coils, it can freely revolve within the outer ring. On the axis of the inner ring is fixed a commutator, having on its periphery a number of insulatsd plates suited to the number of coils, to which plates the ends of the coil wires are connected in such manner that the plates are alternately + and −. The commutator also has on it a + and a − insulated ring, the one connected to all the + plates, and the other to all the − plates. On the plates of the commutator bear a pair of brushes insulated from each other, placed side by side, and of such length, or in such position, that while one of them is in contact with a plate, the other is in contact with the next plate in order. There are also two brushes, one bearing on the + ring, and one on the − ring. When the machine is used as a motor, the two conductors by which alternating currents are led to and from it are provided with double switches, by which they can be connected to the two ring brushes for starting the machine, or, after the machine is started, to the two plate brushes, which brushes are permanently connected to the two terminals of the coils of the outer ring, these coils being connected in series. When the inner ring is driven by mechanical power, alternating currents are produced by it. 1 claim.

17568. "Improved means in connection with multiple electric circuits for measuring current passing in either of them as desired." L. PARIS & SCOTT, Limited, and R. LAURENCE. Dated December 1. 8d. The object of the invention is to provide in connection with multiple electric circuits, or two or more conductors diverging from one common junction, means whereby the current passing in either circuit or conductor can be ascertained independently of that flowing in the other conductor or conductors without having to interrupt the working of the circuits for the purpose, and with the employment of but one measuring instrument. For this purpose there is provided in connection with the several circuits or conductors, and the one measuring instrument, a switch of a character which will allow the current of either of the circuits or conductors as desired to be passed through the instrument and measured. 2 claims.

17590. "Improvements in apparatus and devices for carrying and separating the plates of secondary batteries." H. P. HOLT. Dated December 3. 8d. The plates are suspended by means of a lug cast or formed upon one of the upper corners of each plate, from a rectangular frame resting on an elastic cushion upon the upper part of the cell. The under side or edge of the frame is formed to an inverted camber, so as to distribute the weight uniformly over the top of the cell. 5 claims.

17694. "Improvements in voltaic batteries." H. I. HARRIS and J. GARFORD. Dated December 4. 11d. The object of the invention is to effect further improvements in the voltaic batteries described in specifications 7th July, 1885, No. 8,228, and 30th March, 1887, No. 4,744.

18233. "Improvements relating to duplex electric telegraphs." H. A. TAYLOR. Dated December 13. 8d. Consists in the employment of a compensation circuit comprising one or more electromagnets wound with one or more wires as described. 6 claims.

18659. "An improvement in electric motors worked by alternating currents." SIEMENS BROS. & Co. (Communicated from abroad by A. M. Taylor, of India.) Dated December 20. 8d. Claim:—For starting an electric motor worked by alternating currents, connecting the commutator brushes to the field magnet coils and to a pair of terminals, connecting the alternate plates of the commutator to two rings furnished with brushes connected to another pair of terminals, and providing a double switch whereby the main leads can be connected to either pair of the terminals, substantially as described.

18856. "Improvements in printing telegraphs." G. V. SHEFFIELD and M. LOWENSTEIN. Dated December 24. 8d. The invention comprises a transmitter formed of two rollers adapted to carry forward a perforated strip of paper representing the message, a series of spring actuated fingers, insulated from each other and held in contact with one of the rollers or the paper strip passing between them, so that when the paper passes through the rollers each finger is made to drop on to the roller, wherever an opening in the paper strip occurs in the path of the said finger. This roller is connected with one pole of the battery, the remaining pole of the battery being connected with the ground wire, and each finger is connected with one of the line wires, there being as many line wires as there are characters in the code. The invention further comprises a receiver consisting of a series of steam cylinders arranged in a circle, and connected with printing levers; an electro-magnetic device connected with each cylinder and with one of the line wires, and a series of whistles connected with the steam cylinders, and adapted to be operated by the exhaust.

18981. "An improved plate for electrical storage batteries." M. DOUBLEDAY. Dated December 29. 4d. Consists of grids perforated with any number of holes in each side of the plate which enter large chambers in its centre, each chamber receiving one or more of the holes from each side of the plate, thus giving more surface of contact between the plug and the grid, and also minimising the risk of "short-circuiting," by preventing the plugs working out of the meshes. 2 claims.

CORRESPONDENCE.

Teachers and Students.

In your last issue, in "Notes," the following passage occurs: "In 1872, Mr. Ayrton had not gone out to Japan, much less returned." Now it was Prof. Ayrton himself who suggested that, at the time referred to, he had not returned from Japan, and therefore I feel no complaint can be fairly made against me on this point. I would also remark I never intended to imply, nor did I wish it to be thought I considered I was indebted to Prof. Ayrton for the suppression in the Society's journal of the speech made by me during the discussion on Mr. Preece's paper on "Lightning and Lightning Conductors;" rightly or wrongly, I attributed its suppression either directly or indirectly to the Postal Telegraph Department.

The facts can be stated in a very few words. A paper was read at the Society of Telegraph Engineers, in which my lightning bridges were condemned by Mr. Preece for conforming to a regulation which the then chief engineer of the Postal Telegraphs attached importance to, and insisted upon; in other words, the views of the chief engineer were opposed through the medium of my lightning bridges; the published letter of Mr. Culley, which I quoted, leaves no doubt on this point. Naturally I objected to being made a scapegoat of, and I spoke at some length; the whole of what I said was, however, suppressed in the published proceedings.

Some day I may write the history of the introduction by me of undemagnetisable instruments These instruments of mine have proved to be an advance of great value. Their introduction was nevertheless bitterly opposed by those who afterwards, as officers of the Postal Telegraph Department, had to adopt them simply on their merits.

On the strength of the Government monopoly which made the Postal Department all-powerful, telegraphically, this Department took credit to themselves in a Postmaster-General's report for the introduction of *my* instruments, which they described, truly enough, as the greatest improvement which had been made in the Wheatstone needle telegraphs since their introduction; and a few years afterwards, at the late Loan Collection of Scientific Apparatus, the Postal Telegraph Department exhibited my undemagnetisable instruments as an advance emanating from themselves.

S. Alfred Varley.

December 17th, 1889.

Energy and Electricity.

I am glad to find one statement in which I can thoroughly agree with Mr. Leonard Joseph. *Steam* is not a force. Steam is associated with force and energy; but is not itself force or energy. "Steam is matter; force is not." We know that steam is matter, because it is ponderable; its weight is the same as that of the water converted into it.

But, supposing steam to be imponderable, should we, then, have any evidence of its materiality, or of its analogy to matter, excepting the property of ponderability? Or would it be possible to consider it as a mode of force or of energy?

The question can be readily answered. Apart from the phenomena of momentum and *vis viva*, dependent upon its *mass*, the fact that it is not only indestructible, but absolutely inconvertible into heat or work, would be sufficient to reveal its analogy to matter.

Now, if there be any *thing*—such as is commonly termed *electricity*, or *quantity of electricity*—corresponding to the values $Q = \frac{E}{R}$ in electrostatics (R being here an inductive resistance), and $Q = \frac{E}{R} \times$ time in electro-dynamics (R being here a conductive resistance), this entity is analogous to matter, insomuch as it is not only indestructible, but absolutely inconvertible into work or heat. And, if there be any *thing* corresponding to these values (a point that is fairly open to question) it is certain that this entity may, like *steam*, be associated with varying quantities of force or energy. Thus, as I have said elsewhere, "the same quantity of electricity, passing through conductors of the same resistance (but not in the same time), may, in one case, scorch and rend a tree with the terrific violence of the lightning flash, or may fuse a bar of iron, and in another case be hardly capable of raising the temperature of a gramme of water by a fraction of a degree." But, in both cases, when the energy (Q E) has been partly or wholly expended, the value, Q, remains the same.

In the words of Clerk Maxwell:—"While admitting electricity to the rank of a physical quantity, we must not too hastily assume that it is, or is not, a substance; or that it is, or is not, a form of energy, or that it belongs to any known category of physical quantities. All that we have hitherto proved is that it cannot be created or annihilated, so that if the total quantity of electricity within a closed surface is increased or diminished, the increase or diminution must have passed in or out through the closed surface. This is true of matter. . . . It is not true of heat, for heat may be increased or diminished within a closed surface without passing in or out through the surface. . . . There is, however, another reason which warrants us in asserting that electricity, as a physical quantity, synonymous with the total electrification of a body, is not, like heat, a form of energy. . . . The quantities 'electricity' and 'potential,' when multiplied together, produce the quantity 'energy.' It is impossible, therefore, that electricity and energy should be quantities of the same category; for electricity is only one of the factors of energy, the other factor being 'potential.'"

If Mr. Leonard Joseph can give the *calorific equivalent* of electricity, or can give any instance of the conversion of electricity into heat or work, then I shall be ready to admit that his contention as to the nature of electricity is correct. But I must warn him that all such instances—even when brought forward by a learned professor—have hitherto been proved to be fallacious, and that the idea of electricity being a "force" or "mode of energy" has been relinquished in science.

Desmond G. FitzGerald.